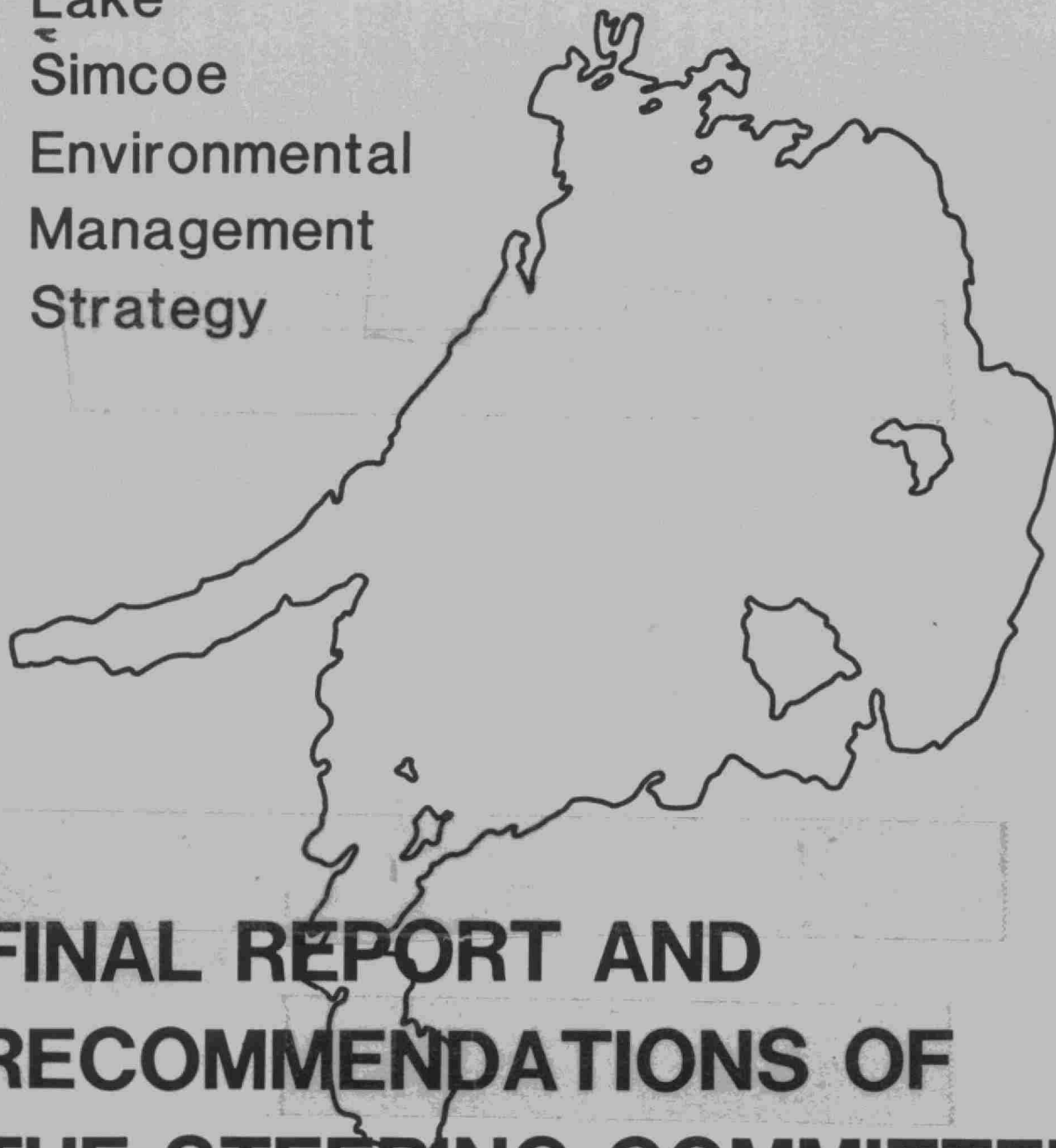


Lake  
Simcoe  
Environmental  
Management  
Strategy



**FINAL REPORT AND  
RECOMMENDATIONS OF  
THE STEERING COMMITTEE**

**1985**

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// **LAKE SIMCOE ENVIRONMENTAL MANAGEMENT  
STRATEGY STUDIES**

**FINAL REPORT AND RECOMMENDATIONS  
OF THE STEERING COMMITTEE**

**October, 1985**

— *ONT. Min. of Env.*

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CURRENT MEMBERSHIP ON THE STEERING COMMITTEE FOR THE  
LAKE SIMCOE ENVIRONMENTAL MANAGEMENT STRATEGY STUDIES

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**SUMMARY AND RECOMMENDATIONS**

## SUMMARY AND RECOMMENDATIONS

### Summary

The Lake Simcoe-Couchiching Basin Environmental Strategy study as well as earlier research and monitoring work have indicated that Lake Simcoe is receiving an excessive supply of phosphorus, causing over-abundant growths of algae. This disrupts the Lake's ecosystem, results in critically low dissolved oxygen levels in the deeper Lake waters and is causing a decline in the populations of desirable cold-water fish species. In response to ongoing concerns with the Lake water quality and recommendations for further research, the Cabinet Committee for Resources Development initiated the Lake Simcoe Environmental Management Strategy (LSEMS) studies, designating the Ontario Ministry of the Environment as lead agency (CCRD, 1979).

The 1979 Cabinet Committee directive initiating LSEMS identified three phosphorus control measures to be undertaken with the objective of reducing annual phosphorus inputs to the Lake to 87 metric tonnes from a projected 1983 loading of 105 metric tonnes. These were:

- (1) the diversion of sewage to the Duffin Creek Water Pollution Control Plant on Lake Ontario from Newmarket and Aurora via the York-Durham trunk sewer to achieve a 6 tonne phosphorus reduction;
- (2) upgrading of sewage treatment at Barrie and Orillia to reduce phosphorus loadings by 8 tonnes, and
- (3) the reduction of phosphorus loadings originating from agricultural activities by 4 tonnes.

The major components of LSEMS were the Phosphorus Sources, Loads and Remedial Measures Studies and the Lake Simcoe Water Quality and Fisheries Studies. The overall objectives of these studies were:

- the determination of phosphorus inputs to Lake Simcoe;
- the identification and evaluation of measures designed to reduce annual phosphorus inputs to the Lake from agricultural sources by four tonnes per year;
- the establishment of base line physical, chemical and biological data to facilitate:
  - . future evaluation of Lake Simcoe water quality,
  - . determination of long range water quality trends, and
  - . measurement of the effectiveness of adopted remedial measures.

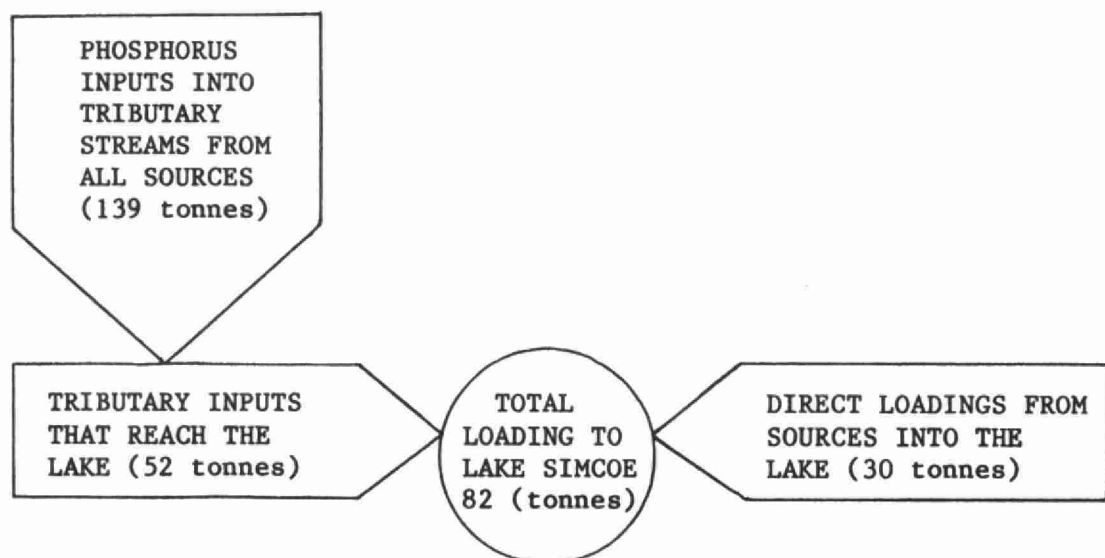
Intensive water quality monitoring stations were established throughout the open Lake, on downstream reaches of major tributaries and at a number of locations on the Holland River System. Research efforts dealt with:

- soil erosion
- streambank erosion and livestock problems
- phosphorus loadings from the Holland River vegetable polders
- phosphorus in the lower Holland River
- algae and aquatic plant growth in the Lake
- stormwater runoff from built-up areas and
- phosphorus in sewage effluent.

The data collected from the tributary monitoring stations indicated a clear pattern of high instream phosphorus concentrations in the southwest portion of the basin, diminishing to the north and east. Exceedances of the Ministry of the Environment guidelines for instream phosphorus concentrations were encountered throughout the basin.

The highest lake water concentrations of phosphorus were consistently found in the southern areas of Cook Bay. Concentrations declined in the Bay towards the main body of the Lake. A similar pattern is found in Kempenfelt Bay with elevated concentrations being found at the head of the Bay and decreasing eastward towards the Lake. The total phosphorus concentrations in the main body of the Lake are consistently lower than those measured elsewhere in the Lake. The types of planktonic algae found in the Lake were typical of those found in nutrient enriched lakes.

Total annual phosphorus loadings to the Lake from sources discharging into the Lake and from the tributaries ranged from 68 to 103 tonnes between 1982 and 1984, and averaged 82 tonnes. On average, tributary loads, originating from various land uses within the sub-basins, were 64% of the total Lake loading:



MEAN ESTIMATED PHOSPHORUS INPUTS INTO LAKE SIMCOE, 1982-1984

Year-to-year loadings exhibit a substantial variation as a result of variations in factors such as total precipitation. Both the 105 tonne projection for 1983 and the 87 tonne target cited above would appear to be within the general range of observed loadings. This implies that a single target loading figure (such as the 87 tonne value) is of limited practical value in establishing implementation strategies. It is more important to set interim phosphorus loading reduction objectives until the oxygen/phosphorus relationship in the Lake is better understood.

Estimated mean annual phosphorus loadings delivered into tributary streams amounted to 139 tonnes during the study period. Only 37% of these inputs were estimated to enter the Lake, reflecting the impact of instream processes such as settling of suspended sediments that remove phosphorus from stream flows.

Estimated loadings to streams from individual sources varied from a high of between 80 and 120 tonnes associated with soil erosion to only 2.9 tonnes associated with streambank erosion. Inputs from built-up areas to streams were estimated to range from 7 to 10 tonnes while loadings from built-up areas directly into the Lake were estimated to range from 13 to 16 tonnes.

The phosphorus control measures proposed by Cabinet Committee have been or are being implemented. The diversion of sewage from Aurora and Newmarket was brought on line in 1984. Upgrading and modification for advanced



phosphorus removal are complete at the Orillia water pollution control plant while work is under way at the Barrie plant.

Modelling analysis suggested that a 2 to 3.5 tonne reduction of phosphorus entering the Lake could be achieved by implementing conservation practices on erosion-prone cropland. Harvesting of duckweed from the Holland Marsh polder canals could result in a 0.5 to 1.0 tonne reduction of phosphorus inputs to the lower Holland River. Practical measures are also available to control phosphorus inputs from streambank erosion and from livestock operations. A 4 tonne loading reduction from agriculture is, therefore, quite feasible. A long time frame of perhaps a decade or more should be anticipated for the implementation of these measures since they involve a great number of private sector participants and extensive promotional work by government agencies.

The investigative efforts and discussions engendered by the LSEMS project have culminated in a series of recommendations that touch on topics ranging from specific remedial action through to broader questions of policy and research. These are outlined in the next section.

## Recommendations

The recommendations that follow constitute an integrated phosphorus control strategy. The order in which they appear does not imply any priority ranking.

## **A. REMEDIAL ACTION REQUIRING IMMEDIATE ATTENTION**

### **RECOMMENDATION A.1**

Erosion of cropland has been identified as a continuing contributor of phosphorus loadings to the tributaries of Lake Simcoe. Remedial actions to prevent cropland erosion and reduce other agricultural sources are feasible and effective but must be promoted within the Basin's farming community. Local, on-farm demonstrations of conservation practices are one of the most effective promotional techniques:

**EXPAND THE USE OF DEMONSTRATION SITES WITHIN THE BASIN TO ILLUSTRATE THE BENEFITS OF CONSERVATION PRACTICES IN AGRICULTURE.**

### **RECOMMENDATION A.2**

Demonstrations alone will not ensure the adoption of remedial actions. In the case of phosphorus loadings from livestock operations, high costs of remedial actions may dissuade farmers from acting. Moreover, while there is general evidence that livestock operations can act as significant contributors, no detailed investigative work has been undertaken in the Basin:

**INVESTIGATE LIVESTOCK OPERATIONS AND INITIATE REMEDIAL EFFORTS WHEREVER SIGNIFICANT SOURCES OF SURFACE OR GROUNDWATER CONTAMINATION ARE FOUND.**

Remedial efforts must stress co-operation and consultation with farm operators and should make full use of available assistance programs.

### **RECOMMENDATION A.3**

A certain amount of streambank erosion occurs naturally along any watercourse, however, livestock access to streams and other factors can accelerate this erosion process. During LSEMS studies, a significant number of streambank sites experiencing a high degree of erosion were inventoried. Sediments from such sites contribute to total phosphorus loadings to the Lake and may also impair local fishery habitat:

#### **REMEDY STREAMBANK EROSION SITES CLASSIFIED AS "MAJOR" OR "SEVERE" IN THE STREAMBANK INVENTORY STUDIES.**

### **RECOMMENDATIONS A.4(1) AND A.4(2)**

Erosion was also encountered along polder dykes lining the channel of the lower Holland River. Underlying causes include the wave action of recreational boats and loss of cattail beds along the banks due to high water levels. A "rule curve" has been established to guide water level management of the Lake. Immediate and long-term actions are required to safeguard these dykes:

- (1) PROTECT POLDER DYKES ALONG THE LOWER HOLLAND RIVER FROM THE WAVE ACTION OF RECREATIONAL BOATS; AND, IN ADDITION, DEVELOP PERMANENT MEASURES TO PREVENT THEIR FAILURE.
- (2) MANAGE THE LEVEL OF THE LAKE TO CONFORM TO THE LAKE RULE CURVE.

#### **RECOMMENDATION A.5**

The Holland Marsh Polder discharges pump-off water with high phosphorus concentrations to the Holland River. During the summer, phosphorus can be removed from this water at relatively low cost by harvesting duckweed growths found in the old river channel passing through the polder:

**MAINTAIN AND IMPROVE A DUCKWEED HARVESTING OPERATION IN THE HOLLAND MARSH POLDER.**

#### **RECOMMENDATION A.6**

Roger's Reservoir on the Holland River East Branch contributes a high phosphorus and sediment load in the spring due to scouring of the exposed bottom sediments behind the dam. Hydraulic conditions permitting, the Reservoir water level should be maintained rather than being drawn down for the winter period; thus scouring would be prevented and the Reservoir would act on a sediment trap.

**DISCONTINUE THE PRACTICE OF DRAWING DOWN, IN THE AUTUMN, THE WATER LEVEL OF ROGER'S RESERVOIR IN NEWMARKET.**

## **B. MONITORING OF WATER QUALITY CONDITIONS**

### **RECOMMENDATION B.1**

Monitoring programs initiated in the Basin since the commencement of LSEMS studies have been instrumental in establishing base-line water quality and quantity data. The impact of remedial efforts and the future status of the Lake can only be assessed if monitoring activities are maintained:

#### **CONTINUE THE FOLLOWING MONITORING PROGRAMS:**

- WATERWORKS MONITORING PROGRAM
- OPEN LAKE MONITORING PROGRAM
- HOLLAND RIVER MONITORING PROGRAM.

### **RECOMMENDATION B.2**

The above mentioned monitoring programs should be maintained as long as the status of Lake Simcoe is in jeopardy. The impact of the Holland Marsh Polder on downstream water quality is important enough, however, to warrant continued monitoring of pump-off waters from the Bradford and Springdale pumping stations. This would insure that the impact of remedial efforts on the Marsh can be assessed through time:

**ARRANGE WITH THE HOLLAND MARSH DRAINAGE COMMISSION TO IMPLEMENT AN ONGOING WATER QUALITY AND QUANTITY MONITORING PROGRAM FOR THE HOLLAND MARSH POLDER PUMP-OFF WATER.**

## **C. AGENCY PROGRAMS AND POLICIES TO REDUCE LAKE PHOSPHORUS LOADINGS**

### **RECOMMENDATION C.1**

A number of agencies are involved in efforts to manage basin resources in order to rehabilitate Lake Simcoe. These agencies have a broad responsibility to ensure that progress is made in implementing remedial actions and that recommended actions are effective:

**TRACK THE IMPLEMENTATION AND EVALUATE THE EFFECTIVENESS OF RECOMMENDED REMEDIAL ACTIONS IN ORDER THAT AGENCY PROGRAMS CAN BE MODIFIED TO RESPOND TO EVOLVING PROBLEMS.**

### **RECOMMENDATION C.2**

Individual agency programs will focus on specific sectors of the population and specific problems. Programs focusing on the agricultural community and, in particular, on soil loss must be given a high priority if rural loading reductions are to be realized:

**EXPAND THE CURRENT SOIL EROSION REDUCTION PROGRAMS UTILIZING FULL-TIME CONSERVATION SPECIALISTS.**

### **RECOMMENDATION C.3**

Resources of the soil erosion reduction program, even with the recommended expansion, will be hard pressed to serve the entire Basin. Maximum benefit will be achieved if they are allocated to areas of the Basin identified during the LSEMS soil loss analysis exercise as major contributors:

**TARGET SOIL EROSION REDUCTION PROGRAMS TO HIGH PRIORITY MANAGEMENT AREAS.**

### **RECOMMENDATION C.4**

A significant amount of phosphorus can be leached out of cultivated polder soils due to the fertilizer phosphorus applied to these soils:

**RECOMMEND TO FARMERS THE USE OF OPTIMAL FERTILIZER PHOSPHORUS APPLICATION RATES TO SATISFY CROP UPTAKE REQUIREMENTS BASED ON PRIOR ANALYSIS OF SOIL PHOSPHORUS LEVELS.**

### **RECOMMENDATION C.5**

Promotional efforts must extend throughout the watershed community to inform various sectors such as cropland landlords and urbanites of their roles and responsibilities:

**PROMOTE THE ADOPTION OF REMEDIAL EFFORTS THROUGHOUT THE WATERSHED POPULATION USING RESOURCES OF THE COMMUNITY RELATIONS PROGRAM OF THE SOUTH LAKE SIMCOE CONSERVATION AUTHORITY, AS WELL AS OTHER AGENCY PROGRAMS.**



#### RECOMMENDATION C.6

Government agencies must continue to fulfil a direct regulatory role in the adoption of phosphorus control measures. To date, this has focused primarily on point sources in built-up areas. Considerable gains in point source phosphorus controls have been made, however, population growth may result in new loadings which can offset these gains:

**PROHIBIT ANY INCREASE IN TOTAL POINT SOURCE LOADINGS FROM MUNICIPAL OR INDUSTRIAL WATER POLLUTION CONTROL FACILITIES UNTIL THE LAKE'S RESPONSE TO AN INCREASE IN PHOSPHORUS LOADING CAN BE RELIABLY PREDICTED.**

This recommendation relies critically on further research into Lake dynamics and, therefore, relates directly to the research recommendations below.

#### RECOMMENDATION C.7(1) AND C.7(2)

Provincial guidelines are currently being formulated which, if complied with, would reduce diffuse source pollution associated with rural municipal drains and urban developments. The guidelines addressing streambank erosion apply to municipal drainage work under the Drainage Act. Urban stormwater, a potentially significant source of future growth in phosphorus loadings, is the subject of new policy initiatives under the Urban Drainage Management Program:

- (1) APPLY THE REVISED DESIGN AND CONSTRUCTION GUIDELINES FOR WORK UNDER THE DRAINAGE ACT TO ALL MUNICIPAL DRAINAGE WORK IN THE BASIN.
- (2) APPLY GUIDELINES FROM THE URBAN DRAINAGE MANAGEMENT PROGRAM TO ALL FUTURE URBAN DEVELOPMENT IN THE BASIN.

In built-up areas, current administrative approvals mechanisms for new developments can be used to enforce construction practices to prevent soil erosion. Effective implementation here would require regular site inspections to ensure that controls are put in place and maintained.

#### **D. THE NEED FOR FURTHER RESEARCH**

##### **RECOMMENDATION D.1**

Certain research initiatives have already been alluded to. The achievement of a better understanding of Lake processes related to phosphorus/algae dynamics, including the potential for phosphorus recycling from bottom sediments, is prerequisite to enlightened planning of future control requirements:

**DEVELOP A PREDICTIVE PHOSPHORUS/ALGAE/OXYGEN MODEL FOR LAKE SIMCOE.**

##### **RECOMMENDATION D.2**

The potential for phosphorus recycling also exists in the lower Holland River. The significance of this to future remedial actions is not now clearly defined:

**CONTINUE STUDIES TO EXAMINE PHOSPHORUS MOVEMENT IN THE LOWER HOLLAND RIVER.**

### **RECOMMENDATION D.3**

Finally, much emphasis has been placed on the need to promote soil erosion control. Unfortunately, most of the research into control measures has been conducted in South and Southwestern Ontario. Findings of previous research may not be directly applicable to the Lake Simcoe Basin due to differences in climate, soils, drainage, etc. Research into local basin factors related to soil loss will be required to evaluate the efficiency of recommended remedial measures:

**ESTABLISH SITES AND SUBWATERSHEDS IN THE LAKE SIMCOE WATERSHED TO INVESTIGATE THE EFFECTIVENESS OF RURAL CONSERVATION PRACTICES.**

## **E. AN ADMINISTRATIVE MECHANISM**

### **RECOMMENDATION E.1**

Efforts to rehabilitate Lake Simcoe will advance on a number of different fronts with the programs and activities of several agencies focusing on promotion, regulation, research and remedial actions. This report has examined the pros and cons of three alternative administrative structures to address important tasks that encompass all of these efforts. These tasks include monitoring overall program achievements, promoting comprehensive coverage of the entire Basin and assuring that equal priority is given to sources in both the rural and built-up areas:

**ESTABLISH AN ADMINISTRATIVE STRUCTURE TO ENSURE THAT WATER QUALITY PROTECTION AND ENHANCEMENT PROGRAMS WITHIN THE LAKE SIMCOE BASIN ARE CARRIED OUT IN AN INTEGRATED AND COMPREHENSIVE MANNER.**

**CHAPTER 1**

**INTRODUCTION**

## 1.0 INTRODUCTION

Lake Simcoe has served for decades as an important recreational resource in southern Ontario. Its beaches and varied fishing opportunities attract cottagers and many visiting boaters, fishermen and campers each summer. Since the Lake is within an hour's drive for more than half the population of Ontario, the use of its recreational facilities is growing steadily.

The general water quality of Lake Simcoe is adequate for most recreational activities but the Lake is not without environmental problems. An excessive supply of phosphorus reaching the Lake is causing an over-growth of aquatic weeds and algae in certain locales. This results in critically low dissolved oxygen levels in deep areas of the Lake and has been linked to a decline of the valuable whitefish and lake trout populations.

Phosphorus has for many years been entering the Lake from a wide variety of sources in both the built-up areas and rural areas. These phosphorus loadings to the Lake promote the excessive growth of aquatic weeds and algae. Accumulations of dead and decaying algae in the deepest parts of the Lake use up dissolved oxygen throughout the summer. Whitefish and lake trout prefer cold, deep water which is normally well oxygenated; however, the low oxygen levels in these deeper waters caused by the decay of algae can hamper the successful reproduction of these fish.

Beginning in the early 1970's, lakeshore municipalities, the South Lake Simcoe Conservation Authority, and the Ministries of the Environment and

Natural Resources have been concerned about these water quality problems and the decline of the cold-water fishery in Lake Simcoe. Local residents and cottagers have also expressed their concerns about these problems. In response to these concerns, the Ontario Ministry of the Environment undertook a four year study into the status of water quality and water use in Lake Simcoe. The resulting report, entitled Lake Simcoe Basin - A Water Quality and Use Study (Ministry of the Environment, 1975) concluded that the general water quality of Lake Simcoe was good, although there was evidence of water quality degradation within the major bay areas. This water quality degradation was the result of man's activities within the watershed.

The report also identified phosphorus as the major nutrient contributing to the eutrophication of the Lake. It was recommended that stringent phosphorus guidelines be proposed for all sewage treatment plant discharges and other sources of waste material from municipalities. In addition, several recommendations to minimize pollution from land drainage and other private sources were presented.

At the same time, the Ontario Ministry of Natural Resources conducted studies into the Lake's fish population. The Ministry established that significant changes had occurred. Limited natural reproduction by lake trout and whitefish was of particular concern. Stresses impacting the fish community included declining water quality, recreational fishing pressures and the establishment of the smelt.



With the quality of the Lake appearing to be in jeopardy, the Lakes Simcoe-Couchiching Report and Steering Committees were formed in 1975. The Report Committee was directed by the Cabinet Committee on Resource Development to assess, identify and deal with the types and magnitude of environmental problems in the Lake Simcoe-Couchiching drainage basin. The resulting report entitled Lake Simcoe-Couchiching Basin Environmental Strategy (Ministry of the Environment, 1979) repeated many of the findings of the 1975 report, and pointed to specific environmental problems such as those associated with population growth and agricultural activities.

The Cabinet Committee responded to the report by designating the Ministry of the Environment as the lead agency in the development of water management control programs for the Basin. As a result, the Lake Simcoe Environmental Management Strategy (LSEMS) study was initiated.

The major objectives of the LSEMS study were subsequently identified as:

- the determination of phosphorus inputs to Lake Simcoe;
- the identification and evaluation of measures designed to reduce annual phosphorus inputs to the lake from agricultural sources by 4 tonnes per year;
- the establishment of base line physical, chemical and biological data to facilitate:
  - . future evaluation of Lake Simcoe water quality,
  - . determination of long range water quality trends, and
  - . measurement of the effectiveness of adopted remedial measures.

**CHAPTER 2**

**THE LAKE SIMCOE BASIN**

## 2.0 THE LAKE SIMCOE BASIN

### 2.1 Physical Features<sup>1</sup>

The Lake Simcoe drainage basin, with a total land and water surface area of 3565 km<sup>2</sup>, is located in Southern Ontario approximately 50 km north of Toronto (Map 2.1). Lake Simcoe is southern Ontario's largest body of water, excluding the Great Lakes. The Lake has a surface area of 725 km<sup>2</sup>, and an average depth of 15 m. Kempenfelt Bay and the eastern portion of the open lake are deep, cold water areas.

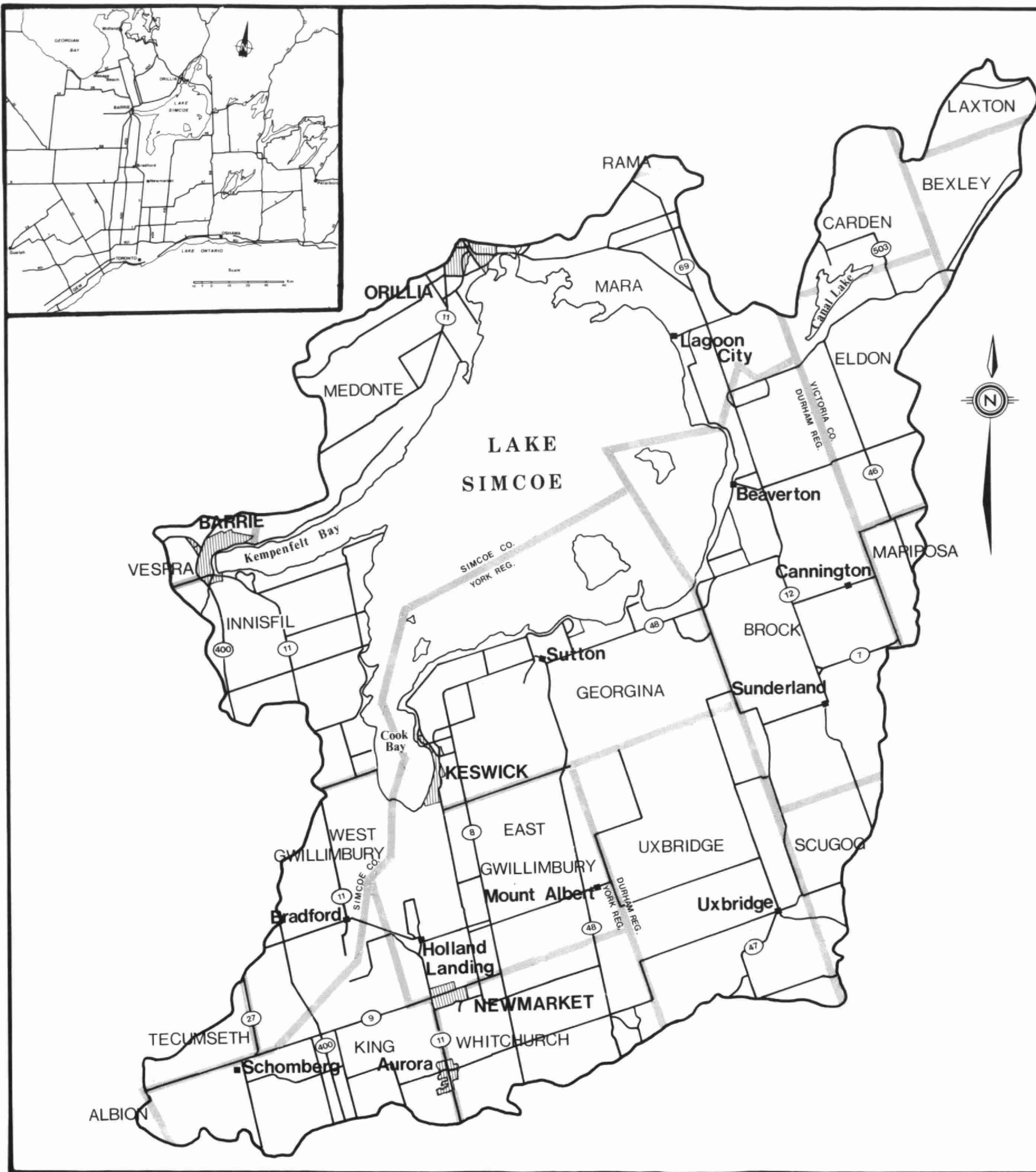
The shoreline of the Lake is 55% cobble, 35% sand, and 10% organic muck. Hard clays, sand and numerous limestone shoals predominate in the littoral or near shore area of the main basin, while the bottom is comprised of organic muds in Cook Bay, Kempenfelt Bay and the deep open water areas (Ministry of the Environment, June, 1975).

The drainage basin is drained by 35 tributary rivers with five major tributaries draining approximately 60% of the watershed area (Map 2.2).

The Talbot River from the west, is a link in the Trent-Severn Canal System joining Lake Ontario and Georgian Bay. Annual mean discharges for the major river systems range from 2 to 4 m<sup>3</sup>/s. Peak flows range from 20 to 60 m<sup>3</sup>/s and usually occur during the spring melt period (LSEMS Technical Report A.1).

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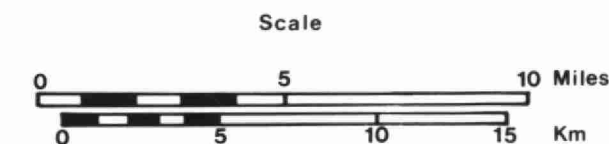
<sup>1</sup> Section 2.1, 2.2 and 2.3 are based largely on LSEMS Technical Report A.



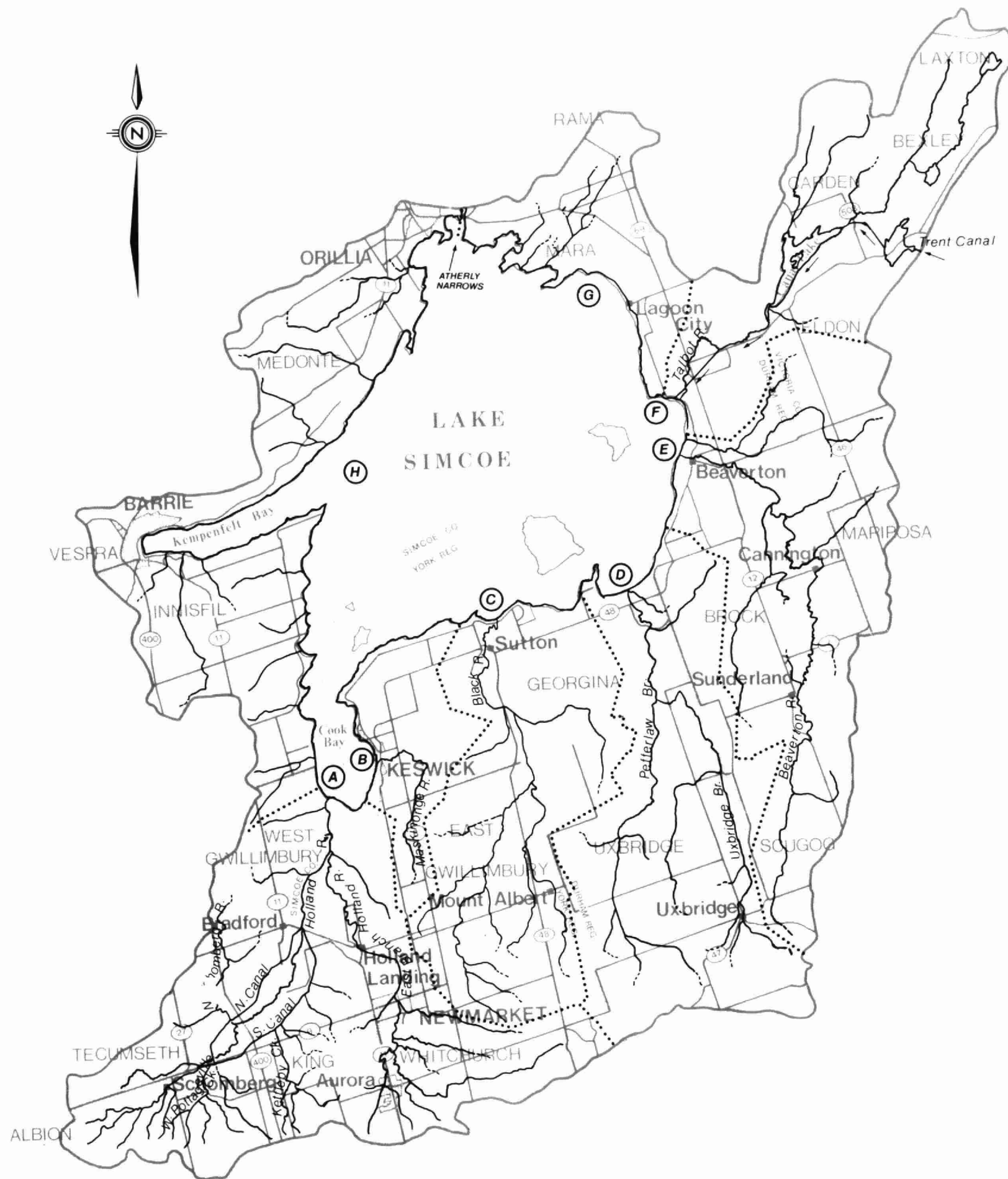
## LAKE SIMCOE BASIN

### LEGEND

- Township Boundary
- Major Urban Centres
- Towns
- Highways



SOURCE: LSEMS Technical Report A

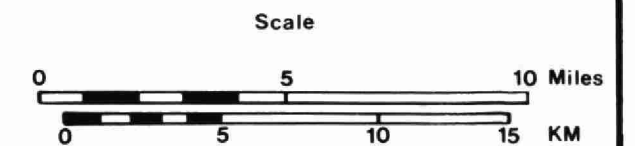


## DRAINAGE SUB-BASINS OF THE LAKE SIMCOE BASIN

### LEGEND

- (A) Holland
- (B) Maskinonge
- (C) Black
- (D) Pefferlaw
- (E) Beaverton
- (F) Talbot
- (G) Northeast
- (H) Northwest

..... Sub-Basin Boundary



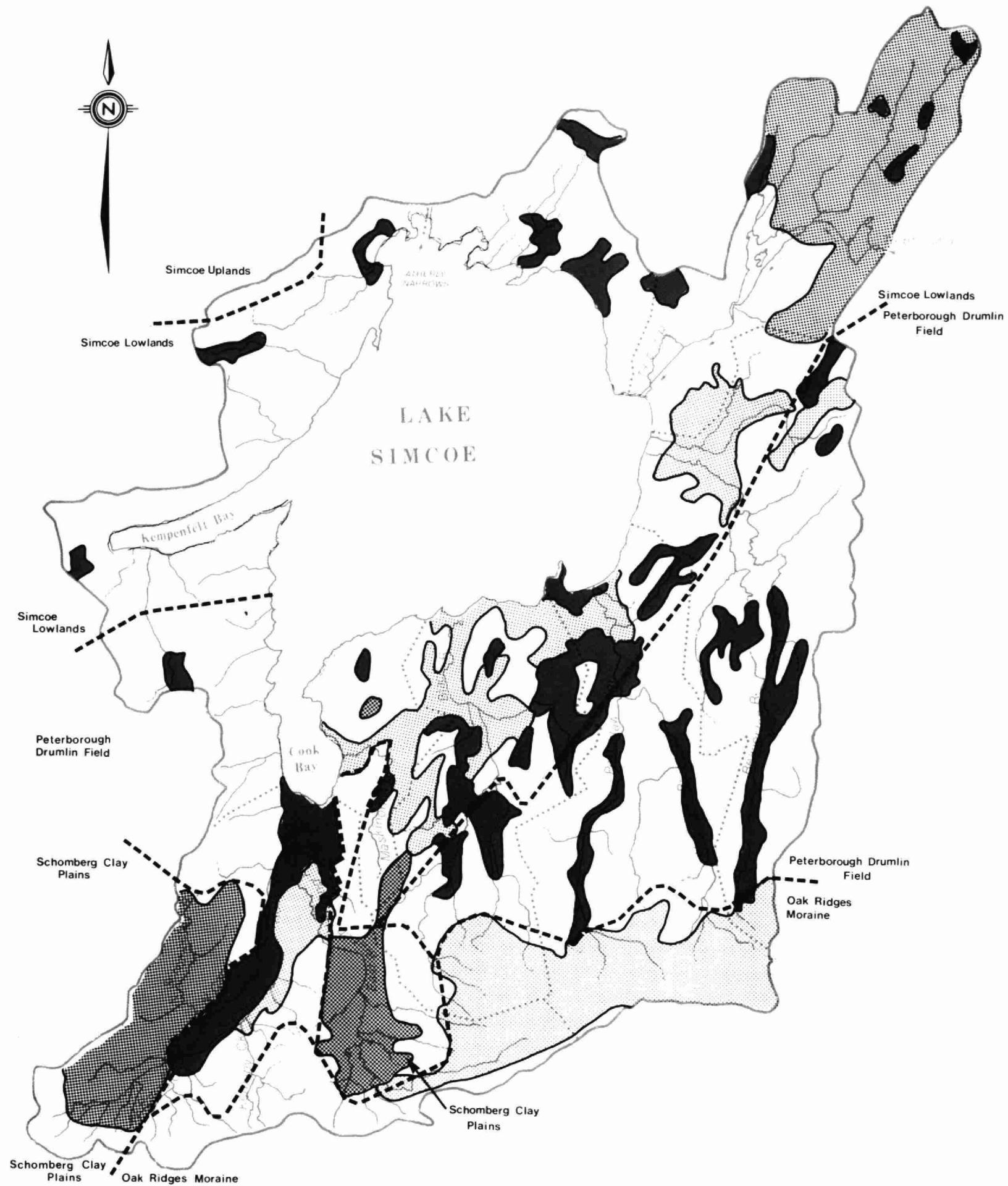
SOURCE : LSEMS Technical Report A

The most southern boundary of the drainage basin lies along a prominent physiographic feature known as the Oak Ridges Moraine (Map 2.3). Most of the basin's major river systems originate within this glacial feature, and have a proportionately higher baseflow or dry weather flow due to the higher yield of ground water from this area. The Moraine is characterized by sandy loam soils with good drainage.

The remainder of the Basin comprises four other major physiographic units to the north of the Oak Ridges Moraine; these are the Schomberg Clay Plains, the Peterborough Drumlin Field, the Simcoe Lowlands, and the Simcoe Uplands.







The Schomberg Clay Plains, found immediately north of the Oak Ridges Moraine, are underlain by a drumlinized till plain with many of the larger drumlins visible at the surface. The predominant soil type is clay loam with good drainage although there are large organic deposits along the major river courses between the drumlins.

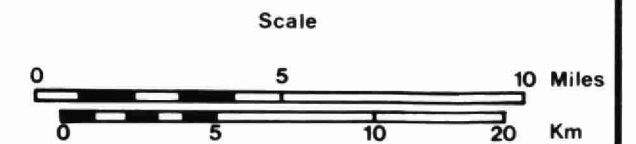
The Lake area is situated entirely within the eastern portion of the Simcoe Lowlands where loam soils with good drainage predominate. Along the northern and western shores of the Lake, the lowland consists of a narrow bouldery terrace confined by a low bluff. The southern and eastern shores are also characterized by some poorly drained sandy loam soils and large organic deposits found along the major river courses. One of the largest organic deposits is along the lower Holland River near Bradford. Since the 1930's, large portions of this area have been dyked and drained for agricultural use.



## SOILS AND PHYSIOGRAPHIC REGIONS

### LEGEND

-  Organic Soils
-  Coarse Textured Soils
-  Coarse To Medium Textured Soils
-  Medium Textured Soils
-  Fine Textured Soils
-  Physiographic Regions



SOURCE : LSEMS Technical Report A

The northwest part of the basin intersects the Simcoe Uplands physiographic region. The soils in this area are generally well drained, being predominantly loam soils with some sandy loams on the upland areas.

## 2.2 Population

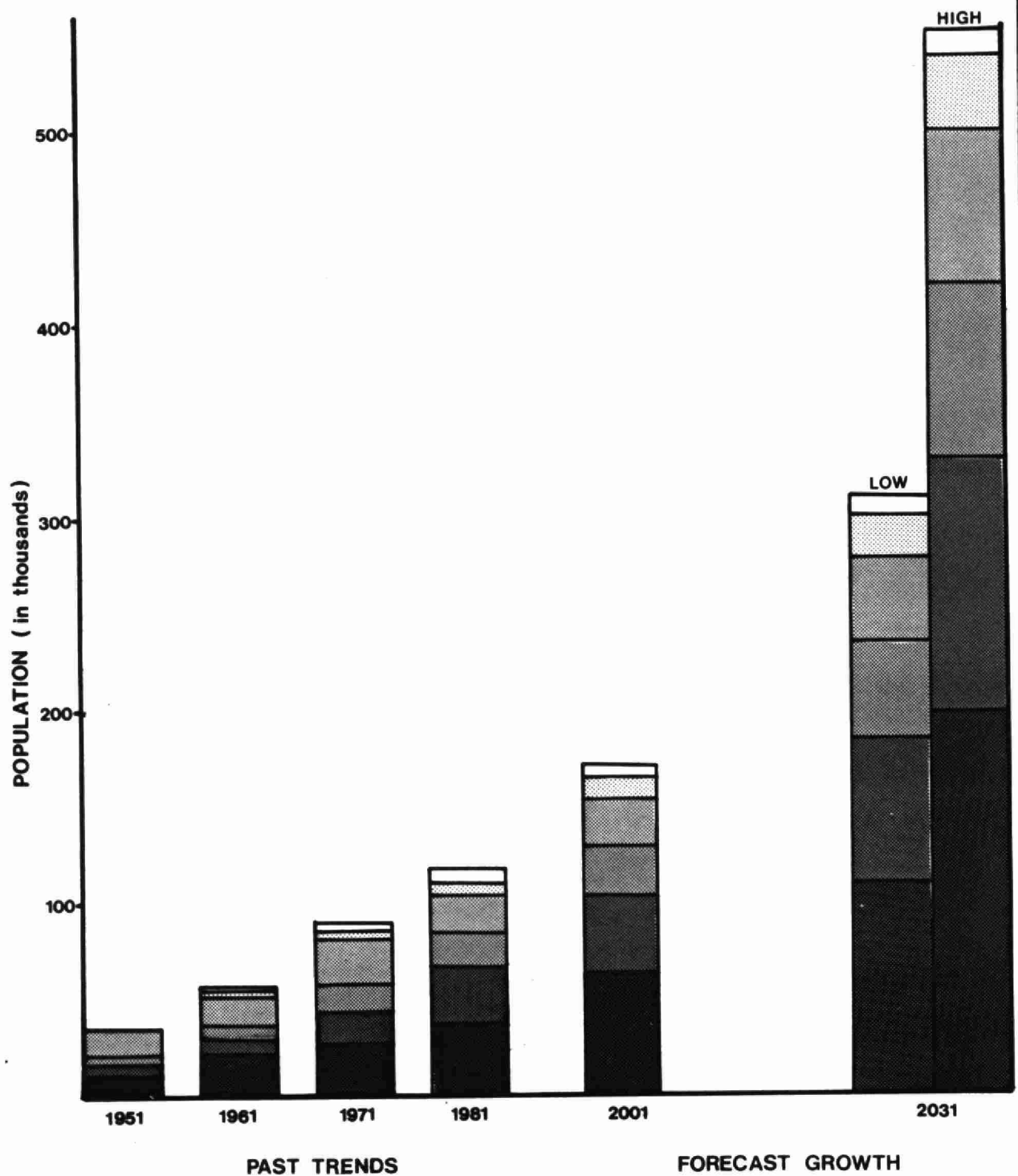
The Lake Simcoe basin has a permanent population of approximately 190,000 persons. The urban areas of the Lake Simcoe drainage basin vary from rural towns supporting agricultural hinterlands to small cities supporting a number of manufacturing and commercial activities. Six of the major communities: Aurora, Barrie, Bradford, Newmarket, Orillia and Uxbridge contain over 90% of the urban population. The total 1982 population for these centres is approximately 126,000. Future population growth is expected to be quite rapid as a result of development pressures from the Toronto area (Figure 2.1).

In addition to this resident population, there is an influx of 40,000 to 50,000 cottagers into the basin over the summer period. There are approximately 12,000 cottages surrounding Lake Simcoe (Ministry of the Environment, 1979).

## 2.3 Land Uses

Total land area of the basin is 2840 km<sup>2</sup>. Approximately 61% (1,740 km<sup>2</sup>) of this area is farmland. Only 2% of the area (65 km<sup>2</sup>) is





## LEGEND



SOURCE: LSEM Technical Report A

PAST AND PROJECTED  
FUTURE POPULATION FOR  
SIX MAJOR URBAN CENTRES  
IN THE LAKE SIMCOE BASIN

urbanized. The remaining 37% is idle or in a natural state, or is used for transportation corridors and aggregate extraction.

The Lake Simcoe basin supports a conventional farm economy with 1770 farms involved in cash crop, livestock and mixed operations as well as a major market gardening industry. In 1981, there were approximately 967 km<sup>2</sup> of cropland, 92% of which was planted to grain, corn and hay.

The Holland River system supports some of the largest cultivated marsh areas or "polders" within the province of Ontario. These polders, shown in Map 2.4, occupy approximately 3300 ha.

The Holland Marsh polder is the largest (2440 ha) and southern most polder of a series extending north to Cook Bay. Water levels within this polder are maintained by pumping water up from the original river channel into the canals outside of the dykes.

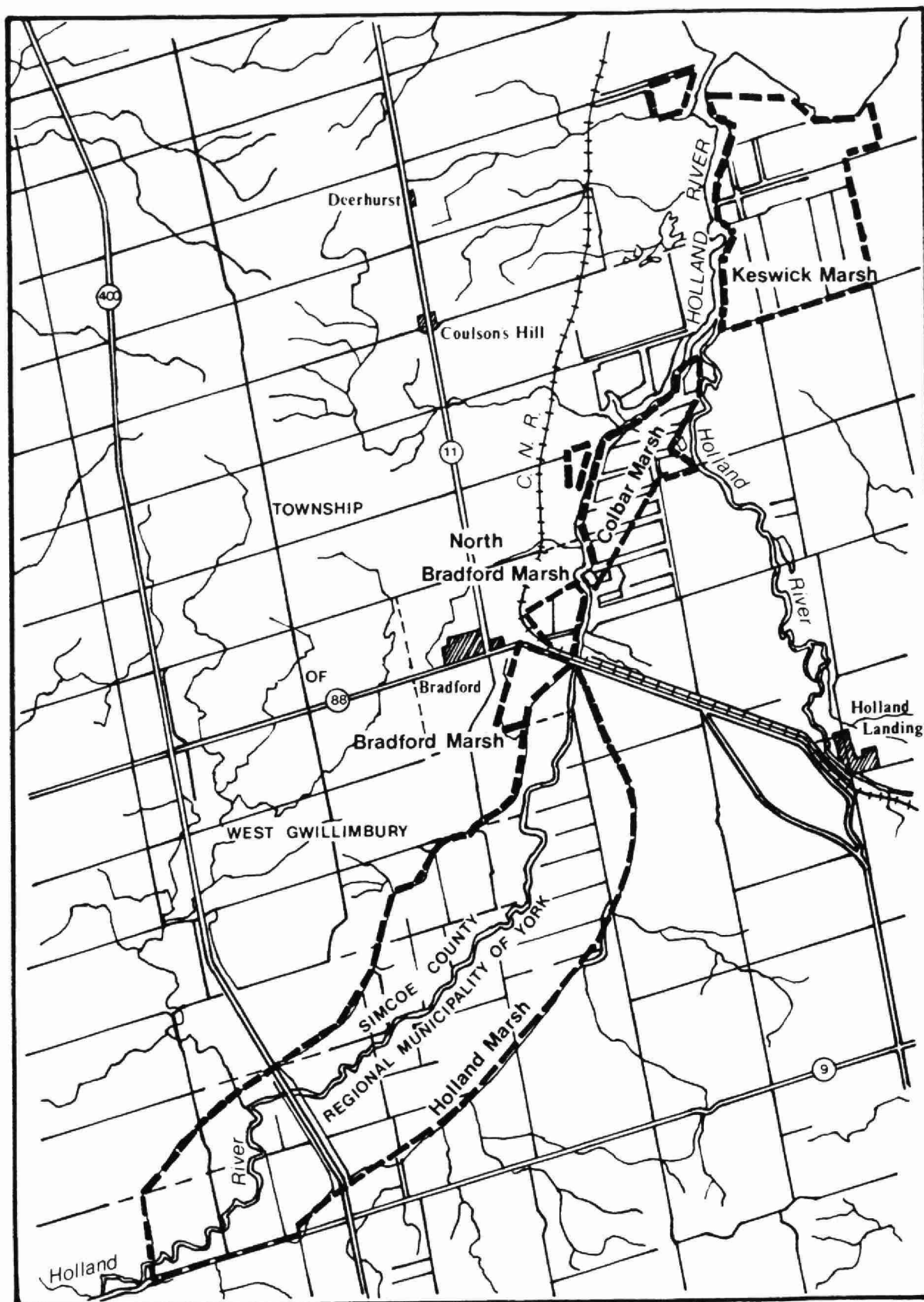
## 2.4 Water Uses

### 2.4.1 Recreation<sup>2</sup>

The waters of Lake Simcoe support very intensive recreational uses throughout the summer and winter.

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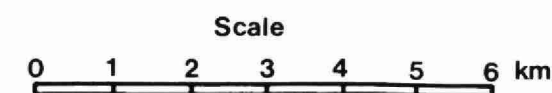
<sup>2</sup> Based on LSEMS Technical Report B and Ministry of the Environment, 1975.



### CULTIVATED VEGETABLE POLDERS ALONG THE HOLLAND RIVER

#### LEGEND

- Marsh Boundary
- Highway
- Road
- +— Railway



SOURCE: LSEMS Technical Report A

Swimming is the most popular activity among cottagers, campers and day visitors on the Lake. Seventy percent of cottagers own or rent boats, while 35 marinas provide a homebase for yachts that can access the Trent-Severn system from the Lake.

Fishing is a popular summer and winter pastime of particular interest in this study since it depends critically on water quality conditions in the Lake. Lake Simcoe's proximity to major urban centres such as the Oshawa-Toronto-Hamilton corridor is primarily responsible for the intense sport fishery that exists. The 1980 survey of Ontario resident and nonresident sport anglers indicated that Lake Simcoe received more fishing effort than any other Ontario inland lake.

The winter fishing effort from 1980-1983 has been estimated to range from 400,000 to 500,000 angler hours each winter, remaining comparable to the 1970's. The total number of fish huts on the ice fluctuates between 2,000 and 3,000, depending on the weather and ice conditions. Generally, 65% of the huts are rented out by commercial operators while the remainder are privately owned.

Persons living within 16 km of the lake account for 50% of the angling effort while other Ontario residents account for an additional 45%. The remaining 5% of the effort comes from anglers living outside the province.

The major fish species sought by anglers during the winters of 1981-1983 were lake whitefish, lake trout, lake herring and perch. The numbers of herring and perch caught each winter have decreased in recent years, while there have been increases in the numbers of whitefish, trout and smelt caught. The current whitefish catch is only a fraction of harvest levels in the 1960's.

Since 1977, the angler effort in the summer fishery has ranged from 158,000 to 246,000 angler hours. A greater range of species is caught in the summer period though overall fishing effort is less. The lower levels of angler effort in the summer are reflected in a smaller overall catch. In 1983 for example, the summer lake trout catch was 52% of the winter catch and the summer perch catch only 12% of the winter catch.

#### 2.4.2 Water Supply and Waste Assimilation<sup>3</sup>

Most municipal water systems in the Basin rely on ground water sources of supply. Lake water is used by Beaverton, Keswick, Sutton and Lagoon City, while Orillia takes some its water from Lake Couchiching at the outlet of Lake Simcoe (Ministry of the Environment, March, 1984). Both Sutton and Orillia reported taste and odour problems as a result of algal contamination of intake water in the 1960's (Michalski and Hopkins, 1971). Well water is the main source of supply for cottages, but 22% of cottagers obtain water directly from the Lake.

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<sup>3</sup> Based largely on LSEMS Technical Report A and Ministry of the Environment, 1975.

In the first quarter of 1984, 11 municipalities discharged treated sewage effluent into the Lake or its tributaries (Ministry of the Environment, March, 1984):

- Aurora	- Lagoon City
- Barrie	- Mount Albert
- Bradford	- Newmarket
- Beaverton	- Orillia
- Cannington	- Sutton
- Holland Landing	- Uxbridge

Since then, the sewage from Aurora and Newmarket has been diverted through the York-Durham trunk sewer line to the Duffin Water Pollution Control Plant on Lake Ontario. Treatment works are being developed for Keswick and Innisfil Beach. The majority of cottagers use septic systems.

### **CHAPTER 3**

#### **WATER QUALITY PROBLEMS IN THE LAKE AND ITS TRIBUTARIES**

### 3.0 WATER QUALITY PROBLEMS IN THE LAKE AND ITS TRIBUTARIES

#### 3.1 Background

The determination of base line physical, chemical and biological data is a primary objective of the LSEMS study. This chapter summarizes the study findings on these data.

While the goal of LSEMS studies is to determine how to restore the Lake water quality, the main thrust of studies centered initially on phosphorus loadings entering the Lake and its tributaries. A number of concurrent monitoring and research programs were, therefore, mounted in the Lake and its tributaries to assess water quality conditions and to investigate processes affecting water quality. Three major monitoring exercises were undertaken expressly for the study. Data from ongoing monitoring programs of the Ministry of the Environment were also used for analysis. These programs are described in Table 3.1 and sampling stations for the LSEMS programs are located on Map 3.1.

In addition to these sampling programs, special field studies for water quality assessment included:

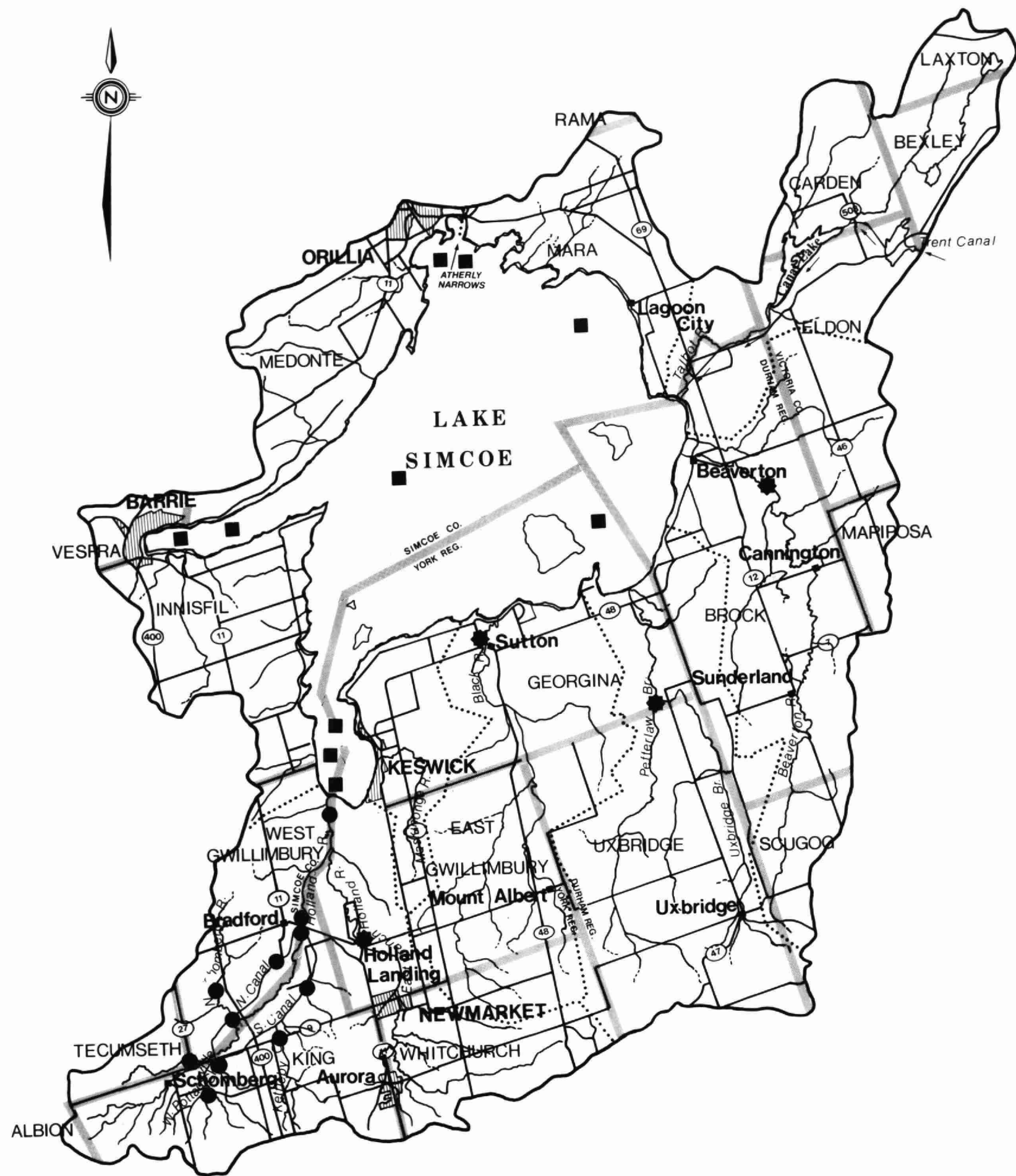
- 1) Phosphorus Regeneration Study - an assessment of phosphorus releases from bottom sediments in the lower Holland River;
- 2) Dichotomosiphon tuberosus Study - an assay of the prolific growth patterns of this recently identified alga.



TABLE 3.1

MONITORING PROGRAMS ASSOCIATED WITH LAKE SIMCOE ENVIRONMENTAL MANAGEMENT STRATEGY STUDIES

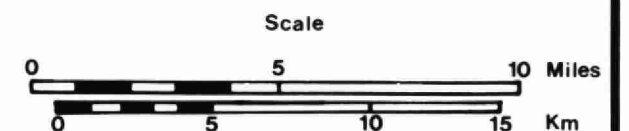
Program	Description
SPECIAL LSEMS PROGRAMS	
Open Lake Monitoring Program - 1980 to 1984	- 10 to 12 lake stations visited on average 8.5 times between ice out (May) and fall turn over (October). - water clarity and algal analysis of the illuminated surface water; dissolved oxygen, temperature and chemical analyses at depths throughout the water column.
Holland River Monitoring Program - 1982 to 1984	- continuous flow gauging of 3 upland tributaries and the Holland Marsh drainage canals; monitoring of Holland Marsh pumping stations - water quality sampling at 4 upland tributary stations, 4 stations along the drainage canals and lower Holland River, and the 2 Holland Marsh Polder pumping stations. - weekly sampling of baseflows, more frequent sampling of high flows and polder flows. - all samples analyzed for water chemistry.
Tributary Monitoring - 1982 to 1984	- single stations established on 3 of the major tributaries (other than the Holland River). - sampling throughout the year on an event oriented basis, an average of 140 samples per year at each station.
ONGOING MONITORING PROGRAMS	
Provincial Water Quality Network - 1966 to present	- monthly grab samples currently collected at 22 tributary stations throughout the basin and analyzed for chemistry, and bacteria
Waterworks Monitoring Program - 1982 to present	- weekly sampling of untreated water from 4 municipal water supply intakes in the Lake, sampling conducted all year. - samples analyzed for chemistry and algae.



## WATER QUALITY MONITORING STATIONS FOR LSEMS MONITORING PROGRAMS

### LEGEND

- Open Lake Monitoring Program
- Holland River Monitoring Program
- Tributary Monitoring Program



SOURCE: LSEMS Technical Report A & B

- 3) Rooted Aquatic Plant Assessment - detailed survey of rooted aquatic plant growth in Cook Bay.
- 4) Historical Sediment Phosphorus Deposition Study - analysis of phosphorus in accumulated Lake bed sediments.

### 3.2 Water Quality

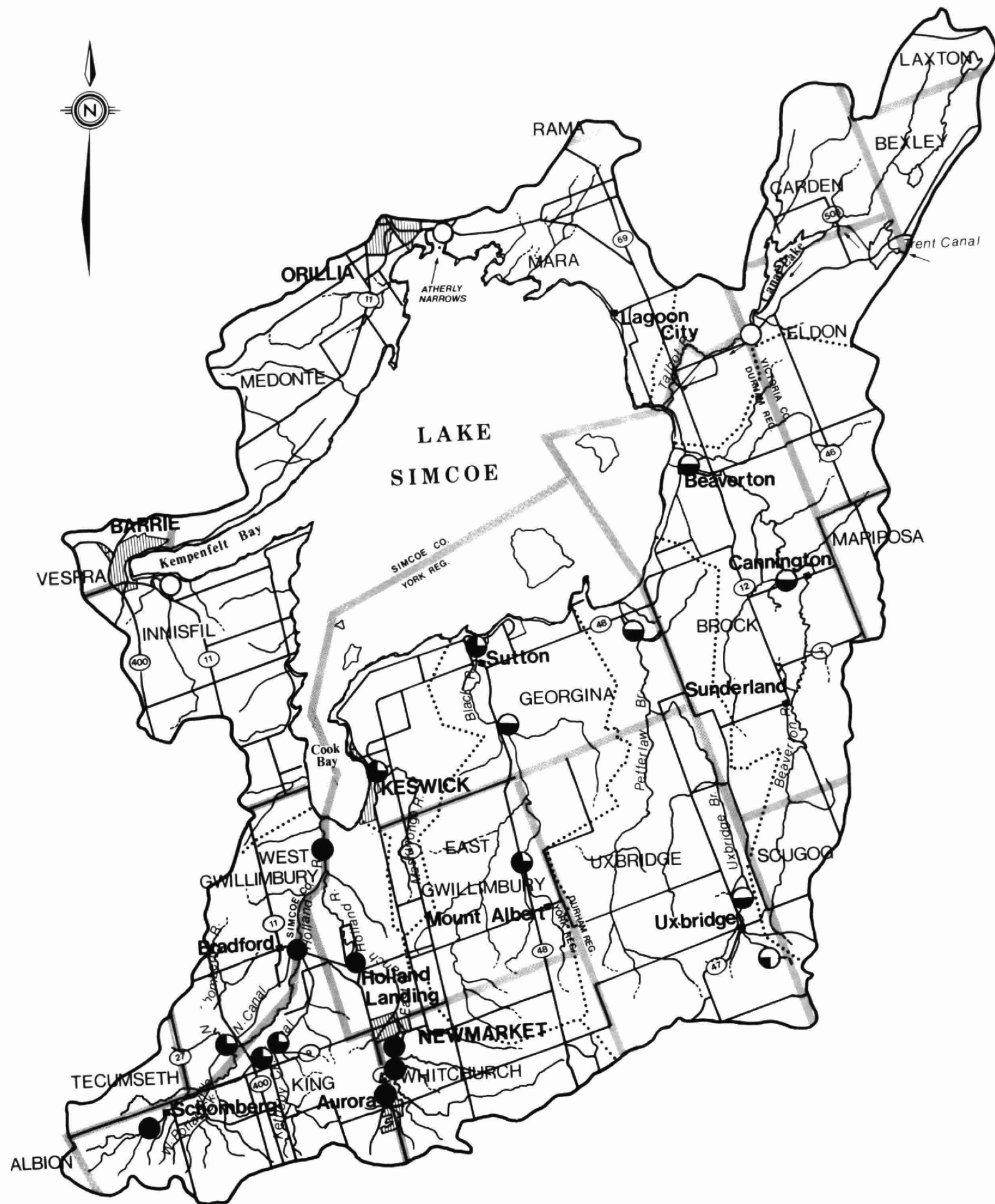
#### 3.2.1 Tributary Water Quality<sup>4</sup>

Total phosphorus data from the Provincial Water Quality Network stations indicates a clear pattern of high concentrations at stream stations to the southwest, with concentrations generally diminishing in streams to the north and east (Map 3.2). Exceedances of the guideline for instream phosphorus concentration, a value of 0.03 mg/L (Ministry of the Environment, 1978), were encountered throughout the Basin. At stations with a 100% exceedance frequency, the soluble fraction of total phosphorus averaged 54% from 1980 to 1983 and ranged between 27 and 75% for individual stations. At other stations, this fraction varied from 12 to 41% and averaged 30%. The high soluble fraction may indicate phosphorus loadings to streams from concentrated sources such as water pollution control facilities.

The analysis of data from the Holland River and the Tributary Monitoring Programs serves to confirm and extend these observations. Mean phosphorus and suspended solids data are lowest for those stations on the Beaverton,

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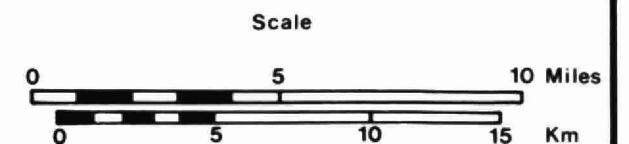
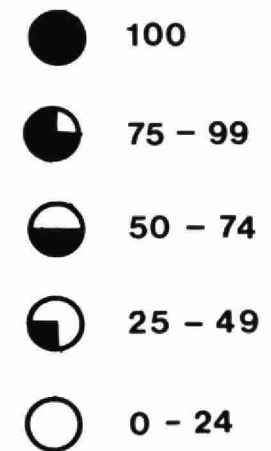
<sup>4</sup> Based on LSEMS Technical Reports A1 and B.



## FREQUENCY OF EXCEEDANCE OF THE PHOSPHORUS GUIDELINE AT PROVINCIAL WATER QUALITY NETWORK STATIONS, 1980 TO 1983

### LEGEND

Percentage of samples with total phosphorus > 0.03 mg/L



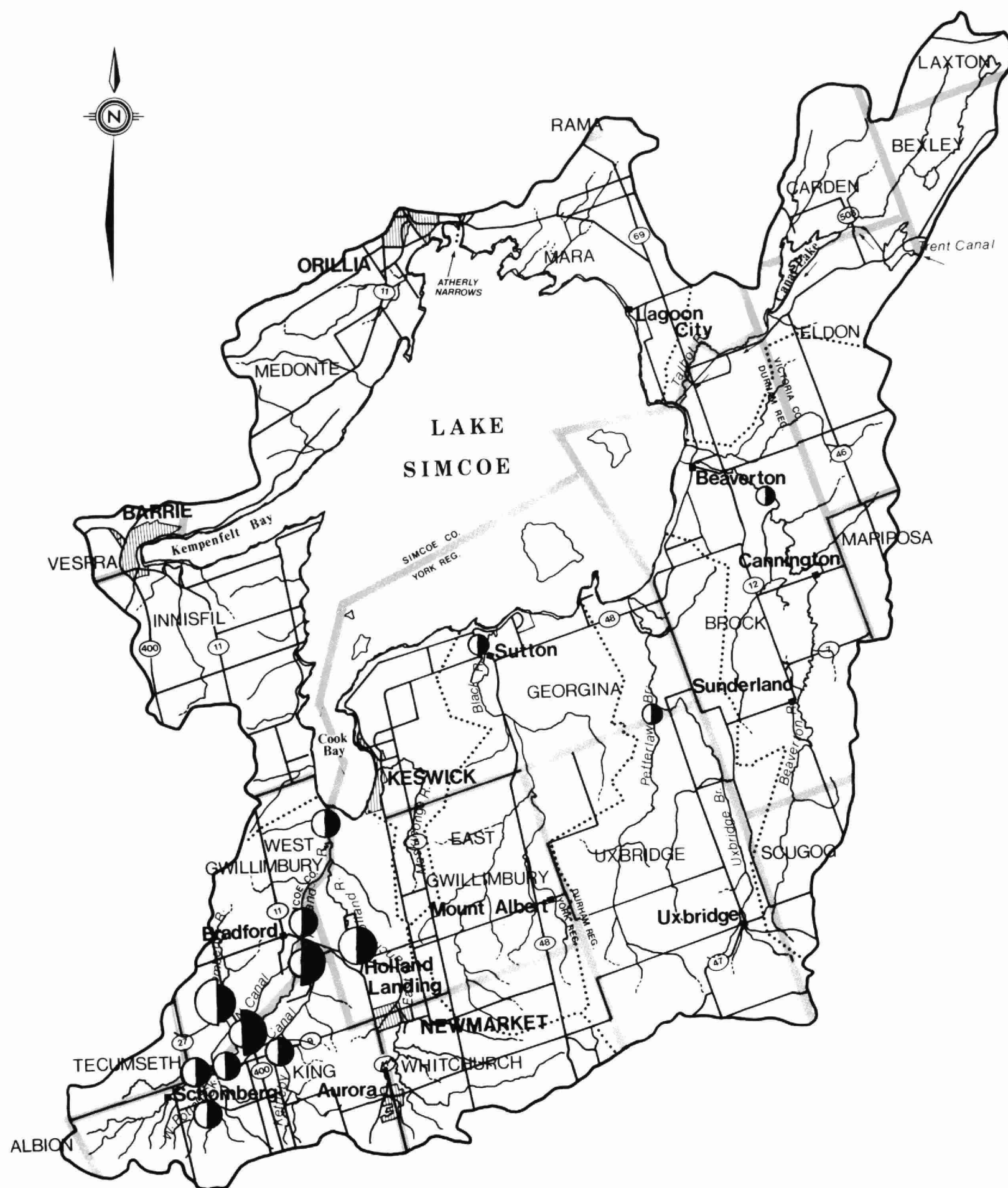
SOURCE: LSEMS Technical Report A1

Pefferlaw and Black Rivers to the east (Map 3.3). The soluble fraction is 20 to 30% of total phosphorus at these stations.





Maximum values for both suspended solids and total phosphorus are highest for the upland stations on Holland River tributaries. Flow velocities at these stations will not have been attenuated by the slow flowing and marshy channels in the level topography of the clay plains. Upon entering the marsh area and travelling on to Bradford, the sediment concentrations in these tributary flows diminish by up to 90% suggesting that there is a high degree of sediment entrapment in these reaches.

From 1982 to 1984, the average annual total phosphorus concentrations of the upland tributaries of the Holland River ranged from 0.06 to 0.33 mg/L, while within the Holland Marsh polder canals they ranged from 0.06 to 0.11 mg/L at the upstream end at Hwy 9, and 0.17 to 0.20 mg/L at the downstream end at Hwy 11. The total phosphorus concentrations in water pumped out of the Holland Marsh polder were three to four times greater than the concentrations in the water within the exterior drainage canals. This accounts for some of the increase in the concentrations from Hwy 9 to Hwy 11. The annual average total phosphorus concentration for the Holland River at Cook Bay was 0.14 mg/L for both 1983 and 1984.

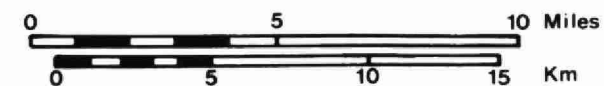
The Holland River East Branch which received sewage effluent from Newmarket and Aurora has the highest annual mean phosphorus concentrations. In 1984, the mean concentration at this station fell 30%



### LEGEND

Mean Suspended Solids (mg/l)	Symbol	Mean Total Phosphorus (mg/l)
0 to 9		0.0 to 0.047
10 to 29		0.050 to 0.199
30 to 89		0.200 to 0.399
90 +		0.400 +

Scale



**SOURCE: LSEMS Technical Report A**



from values in previous years due likely to the diversion of sewage effluent from these two communities.

The study of phosphorus regeneration in the lower Holland River concluded that during the summer months, under conditions of high temperatures and low dissolved oxygen concentrations bottom sediments can release significant amounts of phosphorus to the overlying water. Very low flows give rise to such conditions. The removal of treated sewage effluent discharges at Aurora and Newmarket on the Holland River East Branch may further aggregate the stagnant conditions which favour the release of sediment phosphorus. While this diversion of sewage represents a substantial reduction in phosphorus inputs to the Holland River (6.9 tonnes [T] in 1983), it also significantly reduces the flow in the east branch of the river.

The resulting rate of improvement for the lower Holland River and Cook Bay depends upon the degree to which sediment phosphorus release offsets the reduction of phosphorus inputs achieved through the diversion of Aurora and Newmarket sewage effluent.

### 3.2.2 Lake Water Quality<sup>5</sup>

The highest concentrations of phosphorus in the lake were consistently found in the southern areas of Cook Bay. Concentrations declined to the

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<sup>5</sup> Based on LSEMS Technical Reports B and B1.

north towards the main body of the Lake (Map 3.4). Similarly, elevated phosphorus concentrations found at the head of Kempenfelt Bay decreased eastward toward the main body of the Lake. This pattern of phosphorus attenuation is not unexpected considering the structure of these two bays and the large inputs of nutrients at their upper ends.

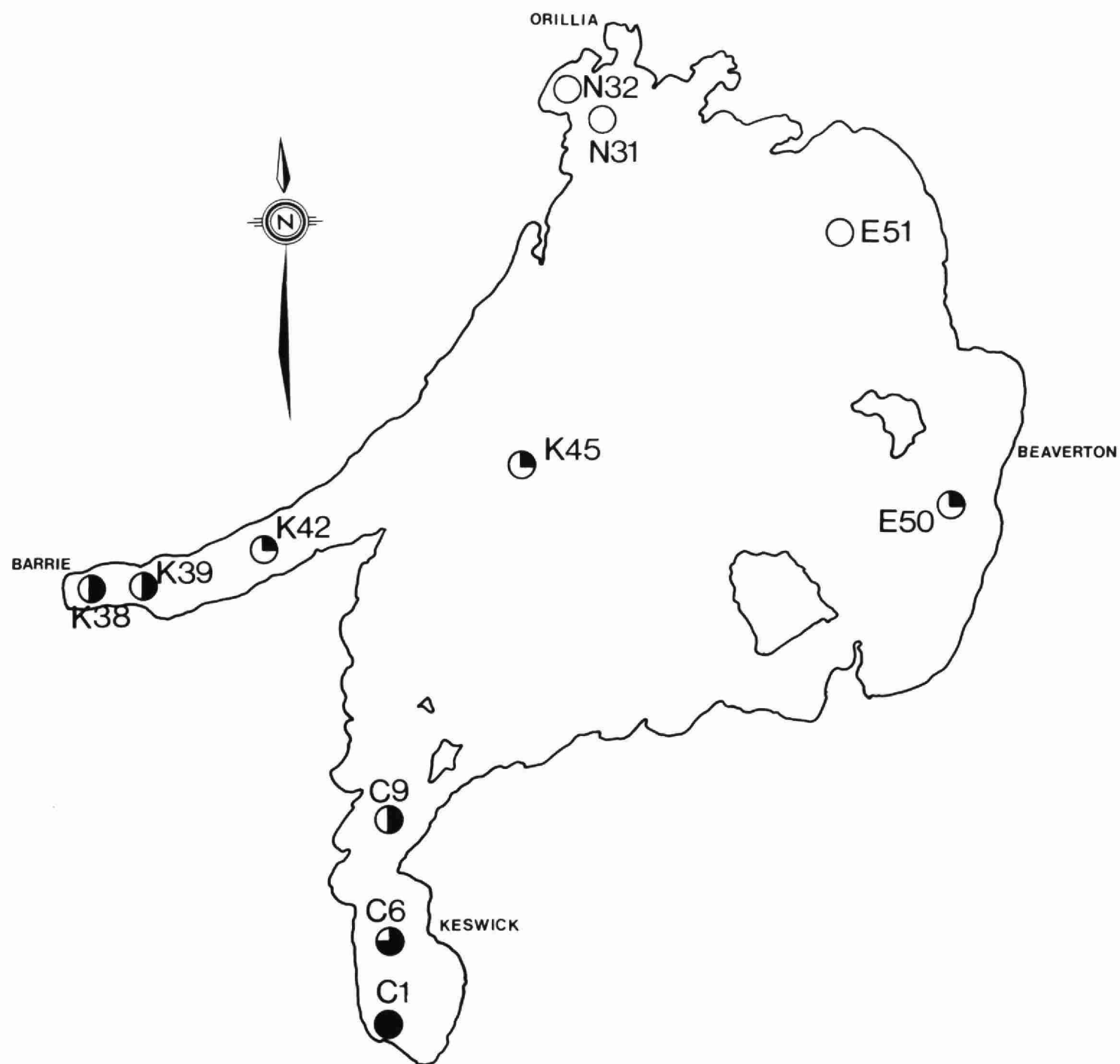
Total phosphorus concentrations at the stations in the main body of the Lake have remained consistently lower than those measured elsewhere in the Lake. Total phosphorus concentrations in the bottom waters were uniformly 1.5 to 2 times greater than concentrations found in the surface waters at the deeper stations (K39, K42, and K45 on Map 3.4).

Water clarity is directly influenced by the quantity of particulate and algal material suspended in the water column. The degree of water clarity determines the depth to which light may penetrate and thus the depth to which algae and rooted aquatic plants may exist. The surface water layer penetrated by sunlight is called the "euphotic" zone.

The lowest degree of water clarity was measured at the southern end of Cook Bay. This station also had the highest densities of free-floating algae. Water clarity improved with increasing distance from the mouth of the Holland River.

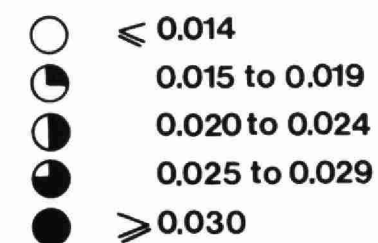
The stations with the highest degree of water clarity were the deep water stations (K39, K42, and K45). These stations also had the lowest densities of suspended algae.





## MEAN TOTAL PHOSPHORUS CONCENTRATIONS IN THE EUPHOTIC ZONE, LAKE SIMCOE, 1980 to 1984

Total Phosphorus Concentration (mg/L)



Note: Five-Year Mean Phosphorus Concentration

Station	Concentration mg/L
K38 (3 year mean)	.020
K39	.021
K42	.017
K45	.016
E50	.018
E51	.014
N31	.014
N32 (4 year mean)	.014
C1	.030
C6	.026
C9	.022

Scale



Source: LSEMS Technical Report B1

Algal analysis in the open lake focused on free-floating unicellular algal species grouped under the name "phytoplankton." In keeping with water clarity data, average phytoplankton biomass was highest in southern Cook Bay (C1) and lowest in the main lake at stations E50, E51, and K45 during all three years.

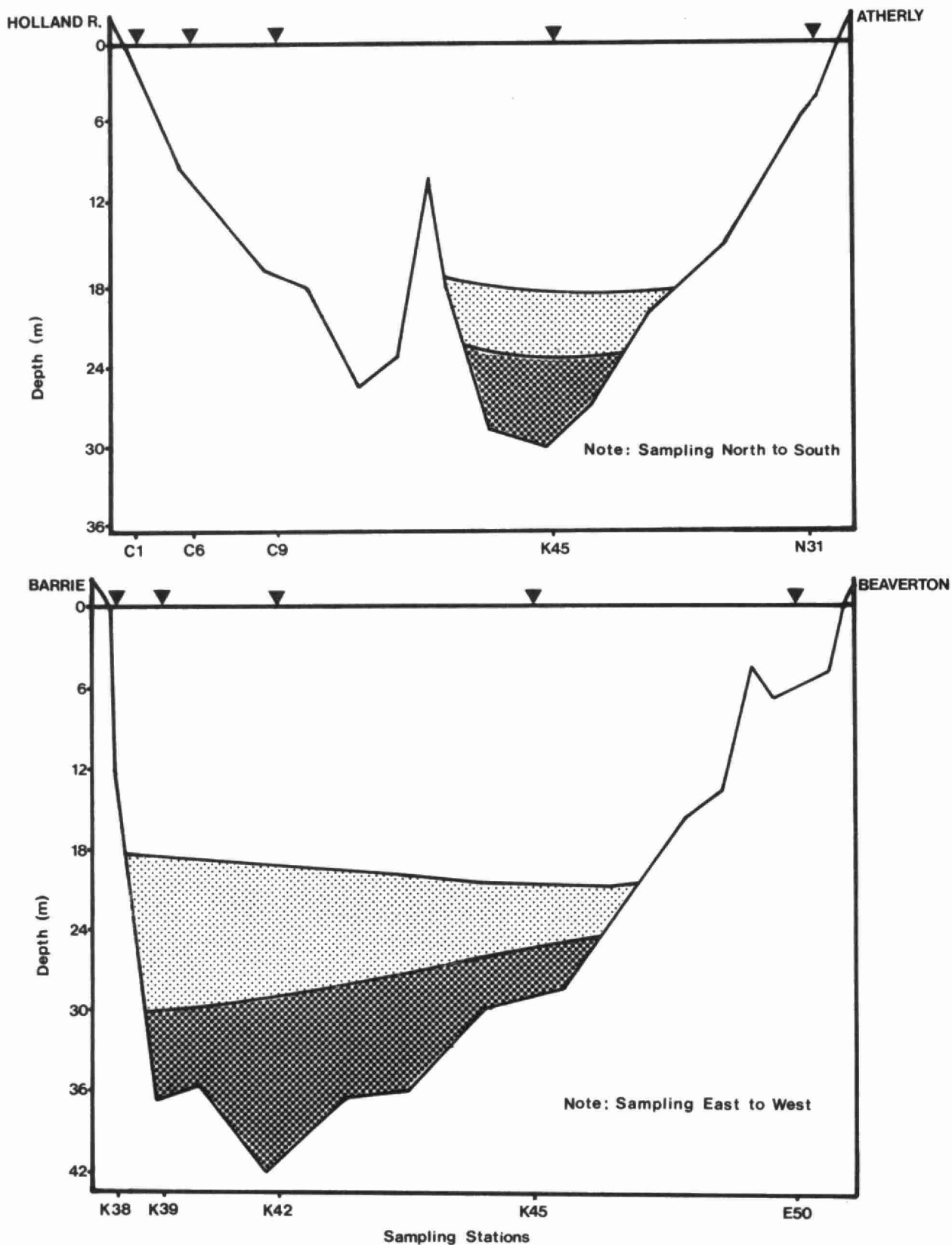
The algae encountered in the Lake were typical of those found in nutrient enriched or "eutrophic" lakes. Small remnant populations of algal species characterizing an earlier nutrient poor (oligotrophic) state were also present. Continued monitoring of both groups will aid in the analysis of water quality trends in the Lake.

Unlike the free-floating phytoplankton, the alga, Dichotomosiphon tuberosus, forms thick mats on silty or sandy bottom sediments wherever light penetration is adequate to support growth. These mats were estimated to cover 58 km<sup>2</sup> or 8% of the Lake bottom and to contain 7.9 T of phosphorus in 1983. In contrast, the extensive colonies of rooted aquatic plants in Southern Cook Bay contain less than 1 T.

Reductions in phytoplankton due to phosphorus controls would increase water clarity and could conceivably increase the potential habitat of Dichotomosiphon. Since this alga is anchored to bottom sediments it may obtain phosphorus from the sediments and would thus not be affected by reductions in phosphorus loadings. The net impact of phosphorus controls on Lake algae populations is, therefore, difficult to predict without a detailed understanding of phosphorus/algae dynamics in the Lake.

All forms of algae will, at the end of their life cycles, die off and settle to the Lake bottom, where their subsequent decay and oxidation will strip bottom water of its dissolved oxygen content. This process is evident in Lake Simcoe in Figure 3.1 showing two cross-sections of the Lake: from the Holland River to Atherley; and from Barrie to Beaverton. The shading on these cross-sections is representative of the Lake's dissolved oxygen concentrations during the latter half of September. These cross-sections clearly illustrate the significant portion of the lake where cold water fish species are subject to stress due to low dissolved oxygen concentrations (less than 5 mg/L).

Once the bottom sediments of Lake Simcoe lose their oxygen, chemical changes take place which lead to the release of phosphorus compounds stored in the mud. Dissolved oxygen loss in the main part of Lake Simcoe including Kempenfelt Bay is apparently not yet severe enough to cause widespread recycling of phosphorus stored in the bottom sediments. This process, however, is operating during midsummer in the lower Holland River and is a major cause of high phosphorus concentrations at that time of the year. The dissolved oxygen concentrations at the bottom of the main lake are, during late summer, near the critical levels usually associated with initiation of phosphorus recycling. Once this process begins, all of the problems associated with excessive phosphorus inputs to lakes become exacerbated. This is because the phosphorus released from the sediment represents an additional input to the lake which cannot be directly controlled. Bottom water dissolved oxygen conditions in Lake



## LEGEND

Dissolved Oxygen Concentration (mg/L)



≥ 5.1



2.1 - 5.0



0 - 2.0

**DISSOLVED OXYGEN  
CONCENTRATIONS IN  
LAKE SIMCOE,  
SEPTEMBER 25, 1984**

Simcoe must be improved for two reasons: to reclaim the habitat for lake trout and whitefish and to lessen the chances of initiating a perpetual cycle of phosphorus release from the bottom.

### 3.3 The Lake Fishery<sup>6</sup>

Prior to 1960, a relatively stable cold-water fish community existed in Lake Simcoe. Since then the Lake's cold-water fish populations of Lake trout and lake whitefish have undergone a dramatic decline, while the warm-water fish populations have thrived. Eutrophication of the Lake resulting from high nutrient loadings and the subsequent deterioration of water quality is considered to be the most significant factor affecting the stability of the Lake's fish populations. Other factors that have altered the indigenous fish community are heavy fishing of cold-water species and the establishment of the smelt.

Commercial exploitation of both the lake trout and whitefish ceased by 1940, but a relatively unrestricted and successful recreational fishery persisted. From 1940 to the present, recreational angling for sport fish has been the principal fishery activity on Lake Simcoe. The exploitation of the whitefish by recreational anglers in the 1960's was not considered to be a significant factor affecting the decrease of the whitefish stock.

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<sup>6</sup> Based on LSEMS Technical Report B and Ministry of the Environment, June, 1975.

The appearance of the smelt in the Lake was first documented in 1961, but no source has been identified. Following their rapid expansion from 1968 to 1970, and their peak in 1973, smelt population levels appear to have stabilized. It has been suggested that failure of the whitefish, and probably of lake trout, may have provided an opportunity for smelt to become established. Although smelt were not shown to have been a causal factor in the failure of the lake trout and whitefish, their presence in significant numbers may impede rehabilitation efforts due to competition for food or the possible predation by smelt of eggs and larval fish of the more desirable species.

Since the mid 1970's, the Ministry of Natural Resources has attempted to rehabilitate the lake trout and whitefish populations. Fishing for smelt has been encouraged since 1975. In 1977, catch and possession limits of two per person were imposed on lake trout and whitefish anglers, in order to facilitate stock rehabilitation. In contrast, the provincial limits are 5 and 25, respectively.

Introductions of lake trout stocks originating from lakes other than Lake Simcoe were made from 1970 to 1977, averaging approximately 50,000 per year. This practice was considered counterproductive to the eventual rehabilitation of the indigenous stocks and was replaced in 1978 by plantings of stock originating from Lake Simcoe parental stock. This stocking has ranged from 37,000 to 120,000 fish per year from 1978 to the present. By controlling the exploitation rate in conjunction with

stocking, a fairly significant level of reproduction potential should be maintained. As the catch records have indicated, it will satisfy the requirements of the recreational fishery. The increase in stock levels of lake trout has probably had a significant influence on stabilizing smelt abundance throughout the 1970's, since smelt have been found to be a significant item in the diet of lake trout in the summer months.

Because the population verges on extinction, an experimental whitefish stocking program was mounted in 1982, using eggs collected from Lake Simcoe fish. The number of fish stocked between 1982 and the present ranges from approximately 13,000 to 27,000 per year. By 1987, the stocking rate is expected to increase to 100,000 per year. The proposed stocking target of 200,000 whitefish yearlings on an annual basis should be sufficient to maintain present population levels and allow an angling fishery as well.

While artificial stocking and other measures seem to have arrested the decline of cold water fish populations, an improvement in Lake Simcoe water quality, particularly the attainment of adequate levels of dissolved oxygen at the lake bottom, would appear to be a prerequisite to the re-establishment of natural, perpetuating stocks of lake trout and lake whitefish.

**CHAPTER 4**

**PHOSPHORUS LOADINGS**



#### 4.0 PHOSPHORUS LOADINGS

##### 4.1 Background

Phosphorus enrichment of lakes is a complex physical, chemical and biological process. It involves the generation of phosphorus from primary sources, the overland and instream transport of phosphorus inputs from these sources to the Lake, and the interaction of resulting phosphorus loadings with algae, aquatic plants and bottom sediments in the Lake.

The behaviour of phosphorus within the Lake has been considered in the previous section. The purpose of this section is to review the current understanding of phosphorus inputs and of phosphorus transport mechanisms in the Basin. Investigations conducted under LSEMS to identify and quantify the individual sources are briefly described below. Estimates of current and future loading levels are presented, and existing or possible future control options are discussed in subsequent sections.

Primary sources of phosphorus are defined here as those activities or processes which give rise to phosphorus movements into tributary streams or directly into Lake waters. Phosphorus from these sources enters surface water in either a particulate or soluble form, the particulate form being associated with fine clay particles and other suspended sediments. Suspended sediments will tend to settle to the stream bed or Lake bottom while soluble phosphorus may be adsorbed onto bottom sediments. Phosphorus in stream bottom sediments may in turn be carried

back into the water column during turbulent high flows or as a result of plant uptake or chemical transformation. Consequently, the phosphorus load discharged at the mouth of a river system will not necessarily equal the phosphorus load entering that systems streams.

Sediments in stream beds and in the Lake constitute a secondary source of phosphorus to the extent that phosphorus released from bottom sediments may have originally been carried there with suspended sediments from primary land sources. No estimate of phosphorus loadings from bottom muds has been made within LSEMS since the necessary estimation tools, namely predictive water quality models for the Lake and the lower Holland River, are not available.

Work within LSEMS has focused on the estimation of phosphorus loads from land sources including background sources, sewage effluent, stormwater from built-up areas, cottages, soil erosion, stream bank erosion, livestock operations and the Holland River polders. Estimation procedures for these are described in turn below:

a) Background Sources

Background sources of phosphorus include an atmospheric load carried directly into the Lake with rains and windblown dust and phosphorus entering tributary streams with ground water discharges providing stream base flows. Rainfall and stream flow monitoring data were used along with simple empirical models to estimate loads from these sources.

b) Sewage and Stormwater Runoff From Built Up Areas

Storm sewer systems and sewage treatment facilities for the major built-up areas are described in Table 4.1. Sewage effluent discharge and quality data for the continuous and seasonal-discharging sewage treatment plants were analyzed to generate annual phosphorus loads for the individual plants. Resulting loads are under-predicted to some extent since inadvertent releases of raw or partially treated sewage during heavy wet weather runoff conditions were not considered in deriving loading estimates.

A computerized model, the Storm, Treatment, Overflow Runoff Model (STORM), was used to simulate stormwater quantity and quality for the six major urban centres. This model requires, as input, continuous precipitation and temperature data, as well as storm sewer catchment and land use data. Stormwater quality and flow measurements for individual storm events are used to adapt or "calibrate" the model so that it accurately represents watershed conditions. The model predicts storm sewer flow volumes and effluent quality for individual storm events.

Growth of urban centres will be the main source of new phosphorus loadings to the Lake and its tributaries in the future. Future loading estimates for the towns and cities are based on population projections provided in Chapter 2.

TABLE 4.1

MUNICIPAL SANITARY AND STORM WATER SYSTEMS

Source: LSEMS Technical Report A

(A) STORM SEWER SYSTEMS

Community	Type of System <sup>1</sup>	Major Receiving Water	Sewered Area (ha) <sup>2</sup>				
			Res.	Com.	Inst.	Ind.	Open
Barrie	separated	Kempfenfelt Bay	975	105	170	250	45
Orillia	separated	Lake Simcoe	860	125	60	105	90
Newmarket	separated, treat.	Holland R.E.	775	100	110	55	60
Aurora	separated	Tannery Cr.	450	45	180	210	35
Bradford	separated	Holland R.	150	40	10	-	3
Uxbridge	separated	Uxbridge Br.	140	15	15	20	11

## NOTES:

<sup>1</sup> Separated = separate storm and sanitary sewers, treat. = treatment provided for some of the storm flows

<sup>2</sup> Res. = residential, Com. = Commercial, Inst. = Institutional, Ind. = Industrial, Open = Open Space

(B) SANITARY SEWAGE TREATMENT SYSTEMS

Community	Type of System	Receiving Water
Barrie	. activated sludge, P. removal (P. removal being upgraded)	Kempfenfelt Bay
Orillia	. activated sludge, P. removal	Lake Simcoe
Newmarket	. was activated sludge with P. removal up to May, 1984	now goes to Lake Ontario
Aurora	. was extended aeration with P. removal up to May, 1984	now goes to Lake Ontario
Bradford	. extended aeration, P. removal	Holland R.
Beaverton	. conventional lagoon, P. removal	Lake Simcoe
Cannington	. conventional lagoon, P. removal	Beaverton R. near mouth
Holland Land.	. conventional lagoon, P. removal	Holland R.
Sutton	. extended aeration, P. removal	Black R.
Uxbridge	. extended aeration, P. removal	Uxbridge Br.
Lagoon City	. extended aeration, P. removal	Lake Simcoe
Mount Albert	. extended aeration, P. removal	Mount Albert Cr.

Future phosphorus loads from urban stormwater runoff were increased in direct proportion to population growth. To estimate future phosphorus loads from sewage treatment facilities, it was assumed that sewage effluent discharged in the watershed would be regulated to 0.3 mg/L total phosphorus, and that Newmarket and Aurora will continue to discharge sewage into the York-Durham trunk sewer line leading to the Duffin Creek Water Pollution Control Plant on Lake Ontario.

New phosphorus loads in runoff originating from areas that are urbanized will be partially offset by the displacement of rural activities. Reductions in rural loads associated with the direct loss of farm land to urbanization will depend on the type of land-uses that are displaced. These are estimated assuming average rural loading rates for those lands that are converted to urban use.

c) Cottages

Cottages along the lake shoreline rely primarily on pit privies or septic tanks with field tile beds to treat sewage. An earlier analysis of this source (Ministry of the Environment, June, 1975) is used here after being adjusted for attenuation in the loamy soils around the lake shoreline.

Phosphorus loadings in these areas may increase either as a result of new cottage developments or a more intense use of existing cottages. An average annual use rate of 90 days/cottage prevailed in 1975 (Ministry of the Environment, June, 1975). The trend to winterizing cottages or

converting them to permanent homes could increase this figure by a considerable amount. On the other hand, the servicing of cottages with sewage collection systems will reduce their total loading. Population growth projections are not available for the cottage areas nor are there data on trends in cottage development that would enable a future loading forecast to be made for cottage areas.

d) Streambank Erosion

Through the combined field work of LSEMS staff and Conservation Authority staff, an extensive inventory of streambank erosion sites was prepared. This inventory was used to assess the relative severity of streambank erosion problems in the Basin.

To estimate loadings from this source, reference was made to a detailed study of streambank erosion, conducted under the auspices of PLUARG (June, 1978). This study concluded that 2 to 32% of the phosphorus loads from a number of small agricultural watersheds were associated with streambank erosion. The unit area loading estimates for the study watersheds ranged from 0.003 to 0.103 kg/ha of total phosphorus. Watersheds that were similar to those in the Lake Simcoe Basin had loading rates at the low end of this range - 0.003 to 0.016 kg/ha. This range was, therefore, assumed and used to derive a range of phosphorus loading estimates associated with streambank erosion in the basin.

e) Livestock

Livestock with access to streams were frequently cited as an important cause of streambank erosion (LSEMS Technical Report A3). Livestock operations also act as primary sources of phosphorus inputs as a result of fecal contamination at cattle access sites and the contamination of runoff from manure storage areas, feedlots, barnyards and manured fields. A modelling approach developed within PLUARG (Robinson and Draper, March, 1978) was used to estimate livestock and poultry related phosphorus inputs to basin streams. The model considers all major pathways to runoff receiving channels.

f) Holland River Polders

Two sources of phosphorus are associated with the Holland River polders--drainage water pumped out of the polders and material eroded from the face of polder dykes by Holland River flows.

Close monitoring of pump running times and water levels and frequent sampling of pumped water for quality analysis enabled a detailed calculation of the total phosphorus loads associated with water pumped from the Holland Marsh polder. Loads were adjusted to account for return flows into the polder as a result of irrigation and other inflows. The resulting net annual loads were extrapolated to account for loadings from the smaller downstream polders.

Aerial photographs of the Holland River were examined to assess the degree of dyke recession. Channel widths were measured on these photographs at 10 sites. No actual estimates of phosphorus loads from this source could be made within the scope of the LSEMS study.

g) Soil Erosion

For the LSEMS study, a number of investigations related to soil loss were undertaken:

- land use, soil and land form factors were analyzed;
- a synoptic scale modelling analysis of gross erosion over the entire basin was completed, followed by more detailed modelling studies of erosion in more erosion-prone areas;
- an analysis was completed to identify areas where a combination of erosion-related and/or overland sediment transport factors resulted in a high degree of sediment delivery to water courses;
- finally, the amount of phosphorus delivered to water courses as a result of soil erosion was estimated.

These studies were undertaken using published data sources in combination with limited amounts of original field data. The large scale of the analysis necessitated the use of simplifying assumptions and analytic procedures. While this will tend to introduce error into the analysis, results are nevertheless indicative of the relative magnitudes of gross erosion and associated phosphorus loadings to streams.

Loadings to tributaries from rural sources could change for a variety of reasons related to changing land-uses and farm management practices.



Changes that can arise from urban development pressures on rural land include (Ecologistics Limited, 1984):

- . increases in nonresident ownership
- . increases in idle land
- . increases in tenant operated farms and rented cropland
- . reductions in livestock operations requiring large capital investments.

Such changes could act to increase or decrease phosphorus loads irrespective of remedial measures that could be adopted. For example, an increase in cropping by nonresident tenants could result in a shift to continuous cash cropping and away from forage-based rotations. Such intensive cropland use has been clearly identified with accelerated rates of soil erosion. Conversely, a reduction in livestock or an increase in idle land could reduce phosphorus loads. It is not, therefore, possible to forecast future rural phosphorus loads in light of the range of conditions that could develop.

#### 4.2 Estimated Phosphorus Loads from Primary Sources<sup>7</sup>

##### 4.2.1 Direct Loadings From Primary Sources to Lake Simcoe

Certain primary sources of phosphorus feed directly to Lake Simcoe waters. They include atmospheric loads, loadings from a number of municipalities and loadings from cottages in shoreline areas.

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<sup>7</sup> Based largely on LSEMS Technical Report A.

a) Background Sources

Total atmospheric loadings deposited directly into Lake waters were estimated to be 13.3, 12.4 and 12.8 T for 1982, 1983 and 1984 respectively. Annual loading variations reflect variations in total precipitation. These estimates are in close agreement with earlier PLUARG estimates (PLUARG, March, 1977).

b) Built-Up Areas

Estimated municipal phosphorus inputs that enter the Lake directly are described in Table 4.2. By the year 2001, phosphorus loads from water pollution control facilities are forecast to fall by 48% relative to 1984 levels. This is due to the assumed regulation of phosphorus concentrations for sewage effluent discharges from the Barrie and Orillia plants. This reduction is partially offset by an increase in urban runoff loads (1.3 T increase over 1984). Moreover, by 2031, phosphorus contributions from sewage effluent are predicted to return to their 1984 levels, while urban runoff loads will be approximately three to five times their 1984 levels. These results assume no changes in phosphorus guidelines for sewage effluent or in requirements for storm water runoff management. Total direct urban loadings in 2031 are predicted to exceed 1984 levels by 3 to 15 T.

c) Rural Areas

The total phosphorus loadings estimated to be generated by shoreline cottages is 8.3 T (Ministry of the Environment, June, 1975). Due to

TABLE 4.2

ESTIMATED PHOSPHORUS LOADS DISCHARGED DIRECTLY INTO LAKE SIMCOE

Source: LSEMS Technical Report A

(A) URBAN STORM SEWERS

Location	1982	1983	1984	2001	2031 <sup>a</sup>	
					Low	High
-----tonnes/year-----						
Barrie	1.8	1.4	1.7	2.9	5.1	to 9.2
Orillia	<u>0.54</u>	<u>0.44</u>	<u>0.51</u>	<u>0.57</u>	<u>1.0</u>	to <u>1.8</u>
TOTAL	2.34	1.88	2.21	3.47	6.1	to 11.0

(B) WATER POLLUTION CONTROL FACILITIES

Location	1982	1983	1984	2001	2031 <sup>a</sup>	
					Low	High
-----tonnes/year-----						
Barrie	7.60	7.50	9.67	3.5	6.3	to 11.0
Orillia <sup>b</sup>	2.10	2.0	2.63	1.4	2.6	to 4.6
Beaverton	0.272	0.530	0.600	} 2.0	3.5	
Sutton	0.298	0.068	0.131			
Lagoon City	--	0.180	0.235			
Keswick <sup>c</sup>	--	--	--			
Innisfil <sup>c</sup>	<u>--</u>	<u>--</u>	<u>--</u>	<u>  </u>	<u>  </u>	<u>  </u>
TOTAL	10.27	10.28	13.27	6.9	12.4	to 19.1

## NOTES:

- a) Low and high values are based on low and high population estimates.  
 b) Future values for Orillia are based on an assumption that infiltration problems at this facility have been corrected.  
 c) Loadings from the Keswick and Innisfil facilities, which are under construction, are included in the future forecasts.

attenuation of phosphorus as cottage effluent percolates through the soil, a loading estimate to the Lake of 3 T/yr is considered reasonable for this source.

#### **4.2.2 Loadings From Primary Sources Into Lake Simcoe Tributaries**

Primary sources of phosphorus that enter the tributaries include phosphorus carried with ground water discharges to streams, loadings from a number of built-up areas, soil and streambank erosion, livestock operations and the polders. With the exception of loadings of sewage effluent and polder pump-off water, these loadings could not be observed and monitored directly. Instead, they were estimated using a variety of modelling approaches as outlined in Section 4.1. Nor could the instream transport mechanisms carrying these inputs to the Lake be readily monitored. Consequently, there is insufficient evidence available to differentiate among the various inputs of phosphorus to a stream once these inputs are intermixed and have been carried any distance within the stream. Phosphorus loads discharged at the outlets of each watershed cannot be apportioned back to their primary sources.

##### **a) Background Sources**

The analysis of stream baseflows indicated a total ground water loading in the order of 2 to 3 T/yr.

b) Built-Up Areas

Storm water loadings from built-up areas on tributaries were comparable to those entering the Lake directly, while sewage effluent loadings are estimated to be considerably less in 1984 and in the future as a result of the Newmarket-Aurora sewage effluent diversion (Table 4.3). Stormwater stands out as a significant source of future growth in loadings.

The reduction in rural loadings of phosphorus from urbanizing lands would be approximately 1 T in 2001 and from 4 to 9 T in 2031. These reductions would partially offset increased storm run-off loads.

c) Rural Areas

The estimated phosphorus input to tributary streams from streambank erosion is 2.9 T/yr for the entire basin, with a range of 0.9 and 4.6 T/yr. During the course of the streambank erosion inventory work, 882 problem sites were found. Thirty percent of these exhibited a significant erosion problem. Four rivers--the Beaverton, Black, North Schomberg and Holland (upstream of the Holland Marsh canals)--accounted for 50% of the 882 sites.

Livestock related contamination, often associated with streambank erosion, appears to be a more significant source. Of the total manure phosphorus generated in the basin every year, 1.3% or 17.5 T are estimated to enter the stream. This value is a very preliminary estimate since livestock operations were not examined in detail in the Basin.

TABLE 4.3

ESTIMATED PHOSPHORUS LOADS ENTERING THE TRIBUTARY WATERS OF LAKE SIMCOE

Source: LSEMS Technical Report A

(A) URBAN STORM SEWERS

Location	1982	1983	1984	2001	2031		
					Low	High	
-----tonnes/year-----							
Newmarket	1.4	1.2	1.3	1.8	3.2	to	5.7
Aurora	1.4	1.2	1.3	2.2	4.0	to	7.3
Bradford	0.19	0.17	0.18	0.30	0.54	to	0.96
Uxbridge	0.15	0.14	0.14	0.15	0.27	to	0.36
Other	<u>1.2</u>	<u>1.1</u>	<u>1.2</u>	<u>1.8</u>	<u>3.2</u>	to	<u>5.8</u>
TOTAL	4.34	3.81	4.02	6.25	11.21	to	20.12

(B) WATER POLLUTION CONTROL FACILITIES

Location	1982	1983	1984	2001	2031		
					Low		High
	-----tonnes/year-----						
Newmarket	3.78	4.39	1.07	0	0	to	0
Aurora	1.66	2.52	1.83	0	0	to	0
Bradford	0.490	0.420	0.234	0.68	1.2	to	2.2
Uxbridge	0.110	0.118	0.121	0.19	0.34	to	0.61
Cannington	0.179	0.210	0.179	} 0.5		1.0	
Holland Landing	0.058	0.030	0.059				
Mount Albert	<u>- -</u>	<u>0.014</u>	<u>0.028</u>				
TOTAL	6.28	7.83	3.52	1.37	2.54	to	3.81

Phosphorus losses from organic soils of the cultivated polders depend on the historical input of fertilizer phosphorus and the amount of mineralization that has occurred. Leaching losses of phosphorus from organic soils are usually several orders of magnitude higher than from mineral soils. Contributing factors are not fully understood; however, studies carried out during this project indicate that there is considerable accumulated phosphorus within the upper layers of marsh soils. Consequently, over 50% of soil samples submitted by Holland Marsh growers indicate that no further phosphorus fertilization is required for optimum crop production at the present time.

The annual load of phosphorus introduced into the Holland River with polder pump off water is highly sensitive to the amount of precipitation and resulting pumping operations. Estimated annual loads from 1982 to 1984 are 15.2, 3.36 and 7.87 T respectively.

Erosion of the polder dykes leads to a direct loading of phosphorus bearing sediment into the lower Holland River. Moreover, if allowed to go unchecked, it threatens the stability of dykes along the Keswick and Colbar Marsh polders. From the earliest, undated photographs to 1978, total bank recession (both sides) varied from 6 m to 107 m. Between 1957 and 1978, there was an average annual recession of 0.69 m for all sites. The worst sites—6 out of the 10 examined—experienced an average annual recession of 1.13 m, while the remaining four sites had negligible bank erosion (0.04 m/yr).

Accurate calculations of phosphorus loads carried into watercourses by sediment eroded from cropland and transported by overland flows were not possible because of a lack of site specific field data. Therefore, a series of modelling and extrapolation techniques were used to project an estimate of these loads.

The analysis commenced with modelling of annual potential gross erosion from cropland (Table 4.4). Resulting modelling estimates are described as "potential" since the analysis conservatively assumes that farmers have not adopted any practices that control erosion. Potential annual gross erosion is in the order of 1 million T/yr in the basin. This amount of total potential gross erosion is equivalent to an average rate of 3 to 4 T/ha. Average rates in the sub-basins vary from a low of 0.3 T/ha in the northeast to a high of 5.3 T/ha in the Holland River Sub-basin.

The synoptic modelling of highly erosion-prone areas suggested that erosion exceeds 11 T/ha on 183 km<sup>2</sup> of the basin (see Map 4.1); this rate was deemed unacceptable by the LSEMS Technical Committee. Detailed modelling of the highly erosion-prone areas revealed that croplands devoted to corn monoculture or to corn and grain rotations were responsible for 32% of gross erosion in the basin even though they accounted for only 6% of the land area.

Results of the analysis of delivered sediment using stream monitoring data show that, on average, only 1% of the potential gross quantity of eroded



TABLE 4.4

ESTIMATES OF POTENTIAL GROSS EROSION FOR THE LAKE SIMCOE BASIN

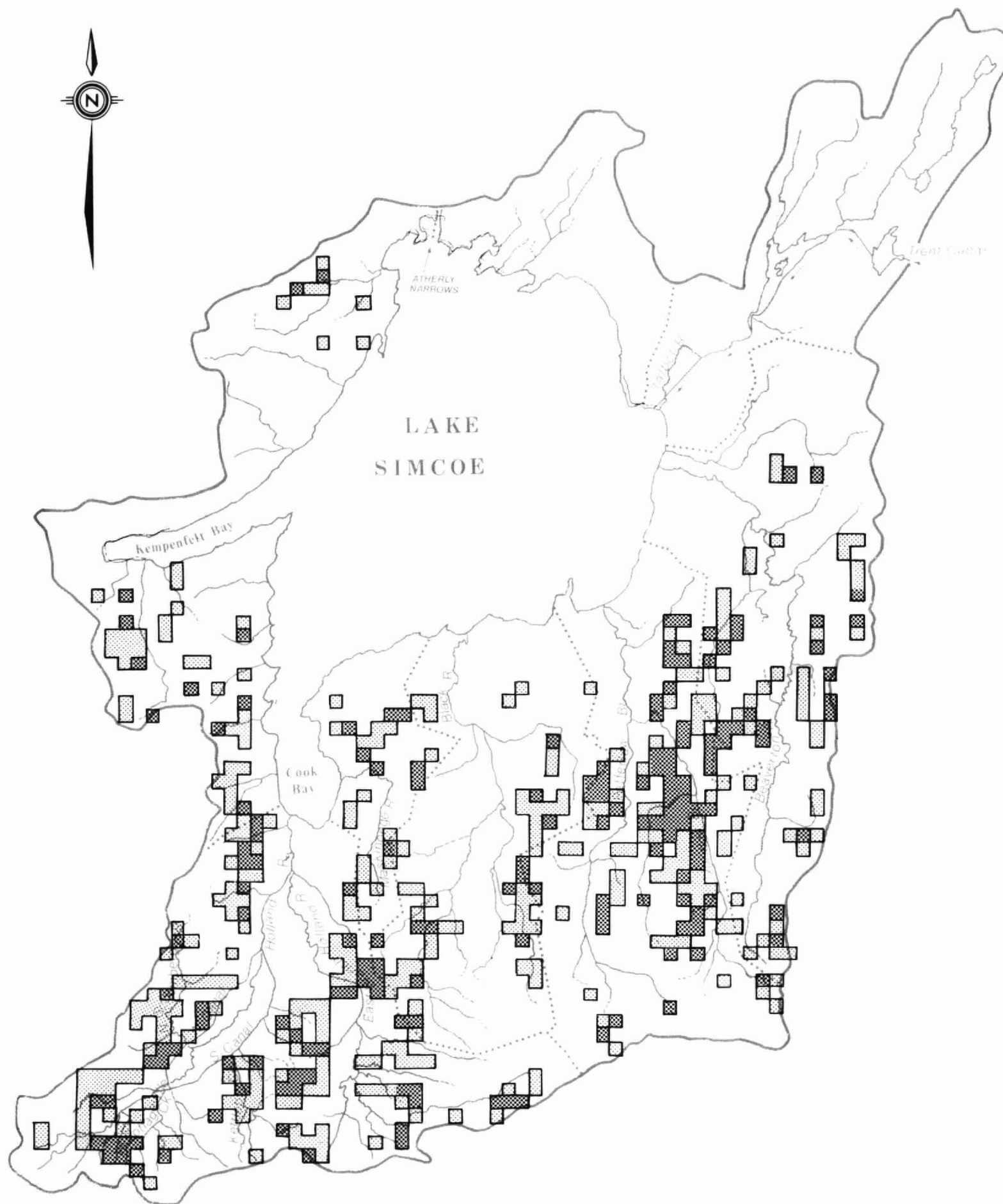
Source: LSEMS Technical Report A

Sub-basin	Area km <sup>2</sup>	Annual Potential Soil Loss			
		Normal <sup>a</sup>	1982 <sup>b</sup>	1983 <sup>b</sup>	1984 <sup>b</sup>
		-----tonnes/year-----			
Holland	596	314,000	380,000	273,000	295,000
Maskinonge	111	44,000	53,000	38,000	41,000
Black	376	112,000	136,000	97,000	105,000
Pefferlaw	437	221,000	267,000	192,000	208,000
Beaverton	443	156,000	189,000	136,000	147,000
Talbot	325	26,000	31,000	23,000	24,000
Northeast	151	4,000	5,000	3,000	4,000
Northwest	402	125,000	151,000	109,000	118,000
TOTAL	2841	1,002,000	1,212,000	871,000	942,000
TOTAL/HA	-	3.5	4.3	3.1	3.3

## NOTES:

a) Based on long-term meteorologic conditions.




b) Meteorologic inputs to the soil-loss model were adjusted to reflect annual conditions.

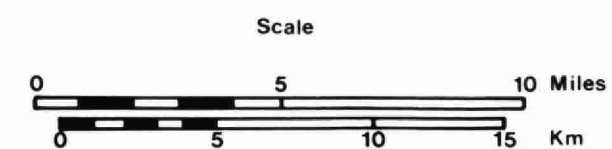


## ESTIMATED ANNUAL GROSS POTENTIAL EROSION

### LEGEND

#### Soil Loss

-   $\leq 6.7$  Tonnes/Hectare/Year
-   $> 6.7$  and  $\leq 11.2$  Tonnes/Hectare/Year
-   $> 11.2$  Tonnes/Hectare/Year



SOURCE: LSEMS Technical Report A

soil reaches the Lake. Conversely, 99% of eroded materials are deposited in downslope areas and in tributary channels.

The estimates derived from the synoptic soil loss modelling exercise are only approximate. Their main value lies in the resulting definition of areas to which erosion control programs should be directed. In order to provide guidance for future land management, this analysis has been taken one step further in an effort to define "priority management areas."

These are areas which generate the highest loads of delivered sediment, and they do not necessarily coincide with the highly erosion-prone areas shown on Map 4.1. Disparities arise due to local differences in drainage density, topography, land cover and other factors affecting the overland transport of eroded sediment to receiving channels. Priority management areas are shown on Map 4.2.

Further modelling analysis based on this delineation of priority management areas results in an estimated phosphorus load to water courses by delivered sediment in the range of 80 to 120 T per year.

#### **4.2.3 Delivery of Tributary Phosphorus Loads to the Lake**

Instream processes affecting phosphorus delivered to water courses result in only a portion of the phosphorus inputs to the tributaries reaching the Lake. This portion is part of the total monitored load of phosphorus coming to the Lake from all sources on the tributary network. As noted



**GENERALIZED PRIORITY MANAGEMENT AREAS FOR THE CONTROL OF EROSION AND SEDIMENT LOADING TO STREAMS**

SOURCE : LSEMS Technical Report A

above, however, insufficient information currently exists to be able to quantify the amount contributed by soil erosion to the total Lake loadings from tributaries.

Phosphorus loads delivered to streams will be altered by the action of instream processes before reaching the outlet of a watershed. Processing will include chemical transformations between soluble and insoluble phosphorus, aquatic plant uptake and release, and settling and resuspension of sediments (U.S. Army Corp, 1982).

In the LSEMS study, no direct research into stream transport was conducted. Evidence of the impact of stream processing is nevertheless apparent when comparison is made of estimated tributary loads to the Lake with estimates of primary inputs to tributary streams.

Tributary loads and other direct loadings of phosphorus to the Lake are provided in Table 4.5. The total annual Lake loading from tributaries averages 52 T for the period of analysis. In contrast, the mean estimated loading delivered to streams from overland sources in the Basin is 139 T, implying a delivery ratio to the Lake of 0.37 or 37%.

The presence of instream phosphorus sinks implies that a phosphorus management strategy should look beyond the immediate impact of remedial actions on primary sources of phosphorus loads. Proximity of the sources to the Lake will be an important determinant of the cost-effectiveness of individual remedial strategies.

TABLE 4.5

## ESTIMATED PHOSPHORUS INPUTS TO LAKE SIMCOE FROM ALL SOURCES

SOURCE	TOTAL LOADING (tonnes/yr)				
	1982	1983	1984	AVERAGE	(% OF TOTAL)
(a) Tributary Loadings from all Sources					
Holland	36.84	18.82	17.27	24.31	( 29.8%)
Maskinonge	2.18	1.23	1.48	1.63	( 2.0%)
Black	7.41	3.17	3.84	4.80	( 5.9%)
Pefferlaw	10.07	7.54	8.22	8.61	( 10.6%)
Beaverton	9.02	5.11	6.98	7.04	( 8.6%)
Talbot	1.29	0.73	0.87	0.96	( 1.2%)
Northeast	0.40	0.22	0.27	0.30	( 0.4%)
Northwest	<u>6.19</u>	<u>3.49</u>	<u>4.20</u>	<u>4.63</u>	<u>( 5.7%)</u>
Total Tributary	73.40	40.31	43.13	52.28	( 64.1%)
(b) Direct Loadings to the Lake					
Cottage Septic Tanks <sup>a</sup>	3.63	2.61	2.82	3.02	( 3.7%)
Urban Centres on Lake					
- Sewage Effluent	10.27	10.28	13.27	11.27	( 13.8%)
- Stormwater Runoff <sup>a</sup>	2.34	1.94	2.21	2.16	( 2.6%)
Atmospheric Deposition <sup>a</sup>	<u>13.3</u>	<u>12.4</u>	<u>12.8</u>	<u>12.83</u>	<u>( 15.7%)</u>
TOTAL	102.94	67.54	74.23	81.56	(100.0%)

a) Annual variations in estimated loadings are based on annual variations in precipitation.

### 4.3 Phosphorus Control Measures<sup>8</sup>

#### 4.3.1 Controls in Built-Up Areas

In the Lake Simcoe Basin, concerns with phosphorus control have already led to the implementation of more stringent phosphorus removal technologies at municipal water pollution control facilities and have resulted in the diversion of sewage from Aurora and Newmarket. Loadings from water pollution control facilities fell from 22.4 T in 1978 to 18 T in 1983, and the 1984 diversion has resulted in a further reduction of about 5 to 7 T.

Upgrading and renovations at Orillia are complete while construction work on the Barrie facility will be completed in 1986. Filtration of effluent from Barrie for phosphorus control will cost \$2.2 million.<sup>9</sup>

Efforts to control stormwater phosphorus loadings from existing built-up areas have not kept pace with efforts in sanitary sewage. However, control measures recommended by regulating agencies for new developments have generally been implemented. The available control options range from operational measures such as enhanced street sweeping and pet litter control programs, through to end-of-the-pipe structural measures involving the use of settling ponds and physical or chemical treatment.

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<sup>8</sup> Based largely on LSEMS Technical Report A.

<sup>9</sup> Personal communication, N. Huggins, Gore and Storrie Consulting Engineers.

In existing sewered areas, operational measures can generally be readily adopted while structural measures are often expensive or infeasible due to difficulties with retrofitting an existing system.

In new developments, retrofit costs are avoided but there must still be an impetus for the adoption of stormwater control measures since these entail a cost but confer no advantage on the developer. An impetus to developers may shortly be provided in the form of stormwater management guidelines being prepared under the provincial Urban Drainage Management Program.

#### 4.3.2 Controls in Rural Areas

##### a) Cottage Areas

New cottage developments are subject to an approval process governing the installation of sewage treatment facilities such as field tile beds. In the Lake Simcoe Basin, approvals are based on the adherence to standard design guidelines.

In certain high density cottage developments central sanitary sewage treatment services are being introduced. This is occurring in both the Keswick and Innisfil areas. Conventional treatment systems with advanced phosphorus removal are being developed in these communities at a total combined cost of \$57 million. By the end of 1985, the Keswick system should be operational and construction of the Innisfil plant will have started.<sup>10</sup>

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<sup>10</sup> Personal Communication, R. Dhillon, Environmental Approvals, Project Engineering Branch, Ministry of the Environment.



b) Soil Erosion

Control of soil erosion and the associated nutrient loading to surface waters has been the subject of several major planning studies in the Great Lakes Basin. Consequently, the various crop management techniques that are available to control soil loss have been extensively tested and demonstrated. Most of this work, however, has occurred in south and southwestern Ontario in relation to programs directed to Lake Erie and its tributaries.

A key concern with current programs has been the need to encourage adoption of practices that will conserve the soil. Farm operators contemplating changes in their crop management practices may have to bear the costs of new tillage equipment, will incur learning costs as they try new systems and are faced with uncertain prospects regarding crop yield impacts of the new systems. Under these circumstances continuing emphasis on the program to demonstrate and promote conservation practices with area farmers is a prerequisite of successful implementation.

The practices themselves vary from making changes in the type of crops grown or the tillage equipment used through to a complete overhaul of farm management systems involving crops, tillage, crop residues, fertilization and the use of herbicides. In any specific application, conservation practices must be tailored to suit the overall farm operation allowing for factors such as the crop rotation, local soils, drainage and topography. For this reason, specific recommendations regarding practices cannot be made at the watershed level.

A modelling analysis was undertaken to assess the potential for soil erosion control in the Basin. Conventional moldboard tillage in the fall was compared to conservation tillage based on fall tillage with a chisel plow. (The chisel plow is an implement that leaves crop residues exposed on the surface to help control soil loss. The moldboard plow turns these residues under, leaving the soil surface unprotected.)

The modelling analysis was undertaken for areas in the basin experiencing erosion rates exceeding 11 T/ha. With conventional tillage, erosion in these areas could range from 253,000 to 321,000 T in a year depending on whether residues remain or are removed. With the chisel plow, these figures drop to 154,000 and 219,000 T respectively. The associated reduction in phosphorus loading to the Lake is estimated to be in the order of 2 to 3.5 T (LSEMS Technical Report A).

c) Streambank Erosion

Streambank erosion is readily controlled using a variety of remedial measures. Erosion along municipal drains can be controlled and prevented using proper construction and maintenance practices.

Rapidly eroding sites along streams that have not been channelized may be caused by natural factors or by activities such as cattle access. Cattle access is readily controlled by fencing and providing an alternative water supply for livestock. Natural causes require remedial structural measures. The total cost of correcting higher priority erosion sites in

the Basin was estimated to lie between \$1 and \$1.8 million. (LSEMS Technical Report A).

d) Livestock

Livestock related phosphorus loadings originate from cattle access to streams and runoff from manure storage areas, barnyards, pasture and manured fields. The cattle access problem is readily overcome as noted above. Other problems are also amenable to varying degrees of control. For instance, runoff from manure in storage can be prevented altogether by using adequate storage facilities. Runoff losses from cropland can be reduced by avoiding practices such as winter spreading or spreading in close proximity to streams.

The costs associated with these measures can be relatively high. For instance, a manure storage facility can cost several thousand dollars. These are costs for which the farm operator may initially perceive little personal benefit. However, when the implications of continued disregard for downstream effects have been identified, most farm operators are prepared to take measures to alleviate the situation. A co-operative attitude can be fostered by water resource managers if they adopt a consultative approach relying on technical and financial assistance. Such an approach is embodied in the Ontario Soil Conservation and Environmental Protection Assistance Program.

e) Polders

Possible controls of the pump-off water from the Holland Marsh Polder include both biological and chemical treatments. Estimated capital costs for chemical treatment ranged from \$370,000 to \$2,370,000 while annual operating and maintenance costs were from \$25,000 to \$88,000. Associated annual removal levels vary from 2 to 6 T of phosphorus.

Biological treatment proved to be more attractive in that it relied on adapting existing practices and had a much lower cost. The proposed scheme involves harvesting the prolific growths of duckweed that inhabit the old channel of the Holland River passing through the Marsh. This plant, which is quite efficient in taking up phosphorus from water, is already removed to facilitate pump operations and reduce duckweed densities in the lower Holland River. An optimal harvesting program would remove 0.5 to 1.0 T of phosphorus from the system at a capital cost of from \$3,000 to \$8,500 and an operating cost of from \$16,000 to \$20,000/yr.

Control measures for dyke erosion along the lower Holland River could include protective structures, controls on boat traffic or measures to minimize high water levels that destroy cattail beds along dyke margins. With respect to the last measure, the Lake level is currently governed by Parks Canada staff in accordance with a prescribed rule curve. The potential for minimizing lake levels would depend on the scope for adjustment built into the rule curve. Other measures would require work on feasibility and design prior to implementation.

## **CHAPTER 5**

### **IMPLEMENTATION ALTERNATIVES**

## 5.0 IMPLEMENTATION ALTERNATIVES

Recommendations of this study range from immediate remedial action through to matters of administration and policy as well as further research. The implementation of the specific recommendations in all cases is achievable through the existing programs and offices of agencies involved in resources management in the Basin. However, the individual recommendations together form a management program embodying both short- and long-term activities and objectives.

There are two prerequisites to the effective implementation of this management program. These are:

1. Implementation actions must apply, in a co-ordinated fashion, to the entire drainage basin covered by the LSEMS studies; and
2. Recommendations dealing with urban and rural based source controls and issues must be addressed with equal priority.

These prerequisites encompass all of the recommendations. Their fulfillment suggests the need for a Basin-wide implementation mechanism. Three such mechanisms have been identified below:

### Option 1: No Overall Co-ordination

Publish the report and recommendations, and leave each agency to carry out its own actions, within its mandate and jurisdiction, each setting its own priorities.

PRO

- . requires no special funding action outside of regular provincial, municipal programs
- . no special efforts required

CON

- . no co-ordination of implementation actions
- . severely limits prospects of successful implementation of LSEMS recommendations
- . increases likelihood of inter-agency conflict
- . likely to attract wide public criticism of all levels of government, as not caring about the future of Lake Simcoe and its drainage basin

Option 2: Designate The South Lake Simcoe Conservation Authority as The Co-ordinating Authority

Under this Option the South Lake Simcoe Conservation Authority would be assigned jurisdiction over the entire basin that drains into Lake Simcoe. As a corporate entity, the South Lake Simcoe Conservation Authority could take advantage of liaison with Federal and Provincial Ministries and agencies directly.

To deal with the areas that are outside the South Lake Simcoe Conservation Authority boundaries, but within the drainage basin the South Lake Simcoe Conservation Authority could set up an Advisory Implementation Committee made up of representatives from municipalities around the Lake.

PRO

- . South Lake Simcoe Conservation Authority has a proven record of effective co-ordination
- . no special funding required to establish an administration
- . special arrangements can be made for representation from areas not presently within South Lake Simcoe Conservation Authority
- . implementation could begin immediately

CON

- . resistance may be encountered to giving South Lake Simcoe Conservation Authority any authority for areas outside its present boundary, thereby delaying start of implementation.
- . expansion of South Lake Simcoe Conservation Authority mandate and role could pose operational/jurisdiction problems with provincial and municipal agencies that currently exercise authority in overlapping programs

Option 3: Province Establishes a Special-Purpose Lake Simcoe Basin

Commission

PRO

- . high public profile
- . effective co-ordination with clear focus on basin objectives
- . avoids the issue of South Lake Simcoe Conservation Authority jurisdiction outside its current boundaries
- . can effectively address the land use planning issues inherent in basin issues



CON

- . high start-up cost for new agency
- . increased risk of local community resistance to yet another agency at public expense
- . high potential for rivalry with existing provincial and municipal agencies, and confusion of roles and mandates
- . risk of reducing voluntary co-operation, thereby protracting implementation

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**AND**

**APPENDIX**

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## APPENDIX

### MEMBERSHIP OF THE TECHNICAL COMMITTEE OF THE LAKE SIMCOE ENVIRONMENTAL MANAGEMENT STRATEGY STUDY

W. Lammers, Central Region, Ministry of the Environment (Chairman and Co-ordinator)

S. Black, Water Resources Branch, Ministry of the Environment

D. Draper, Water Resources Branch, Ministry of the Environment

R.L. Des Jardine, Maple District, Ministry of the Natural Resources

H. Gault, South Lake Simcoe Conservation Authority

R. Gregg, retired, Ministry of Agriculture and Food (past member)

D. Henry, South Lake Simcoe Conservation Authority

K. Nicholls, Water Resources Branch, Ministry of the Environment

B. Noels, South Lake Simcoe Conservation Authority

G. Robinson, Water Resources Branch, Ministry of the Environment

R. Shaw, Central Region, Ministry of the Environment

S. So, South Lake Simcoe Conservation Authority (past member)

S. Singer, Soil and Water Management Branch, Ministry of Agriculture and Food

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